Corridor System Management Plan (CSMP)
Final Report
Orange County SR-55

March 27, 2014

System Metrics Group, Inc.

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1. INTRODUCTION

This document represents the Comprehensive Performance Assessment Report of the Orange County State Route 55 (SR-55) Corridor System Management Plan (CSMP) developed by the California Department of Transportation (Caltrans). The SR-55 corridor runs in a north-south direction from the City of Newport Beach at Post Mile 0.0 to the Riverside Freeway (SR-91) at Post Mile 17.876. The performance assessment is conducted for the freeway portion of the SR-55 (from 19th Street to SR-91) as arterial data is not available for the arterial portion of SR-55 (from Finley Avenue to 19th Street).

A CSMP aims to define how corridors will be managed in the short to medium term, focusing on operational strategies in addition to the already funded expansion projects. The goal is to get the most out of the existing system and maintain or improve corridor performance.

This report presents performance measurement findings, identifies bottlenecks that lead to less than optimal performance, diagnoses the causes for these bottlenecks in detail, develops micro-simulation models that evaluate different project scenarios, and quantifies the associated congestion relief benefits of these scenarios.

This CSMP should be updated by Caltrans on a regular basis since corridor performance can vary dramatically over time due to changes in demand patterns, economic conditions, and delivery of projects and strategies among others. Such changes could influence the conclusions of the CSMP and the relative priorities in investments.

It is recommended that updates occur at least every two to three years or when other major studies have been completed to ensure that the existing CSMP report findings and recommendations are still acceptable. To the extent possible, this document has been organized to facilitate such updates. The following discussion provides background to the system management approach in general and CSMPs in particular.

What is a Corridor System Management Plan (CSMP)?

This CSMP is the first attempt to integrate the overall concept of system management into Caltrans' planning and decision making processes for the SR-55 corridor. Traditional planning approaches identify localized freeway problem areas and then develop solutions to fix those problems, often by building expensive capital improvement projects.

This SR-55 CSMP focuses on the system management approach with a greater emphasis on using on-going performance assessments to identify operational strategies that yield higher congestion reduction and productivity benefits relative to the amount of money spent. The performance assessment involves analyses of existing conditions and identification of corridor bottlenecks and causality. CSMPs also include development of micro-simulation models that test short-term and medium- to long-term project scenarios and detailed benefit-cost assessments to determine the return on investment for each scenario.

Caltrans develops integrated multimodal projects in balance with community goals, plans, and values, and Caltrans seeks to address the safety and mobility needs of bicyclists, pedestrians, and transit users in all projects, regardless of funding.

Bicycle, pedestrian, and transit travel is facilitated by creating "complete streets" beginning early in system planning and continuing through project delivery, maintenance, and operations. Developing a network of complete streets requires collaboration among all Caltrans functional units and stakeholders.

As the first-generation CSMP, this report focuses more on reducing congestion and increasing mobility through capital and operational strategies. Future CSMP work will further address pedestrian, bicycle and transit components and seek to manage and improve the whole network as an interactive system.

What is System Management?

With the rising cost and complexity of construction and right of way acquisition, it is more challenging to construct large-scale freeway projects. Compared to the growth of vehicle-miles traveled (VMT) and population, congestion is growing at a much higher rate.

Exhibit 1-1 shows Orange County congestion (measured by average weekday vehicle-hours of recurring delay), VMT, population, and urban freeway mileage between 1989 and 2008 from HICOMP reports. HICOMP reports are only available up to 2008. Subsequent to 2008, Caltrans produces the Mobility Performance Report (MPR) to document congestion. Due to different methodologies used to analyze congestion, it is not recommended to compare the results of these two sources.

Over that 20-year period, the following should be noted:

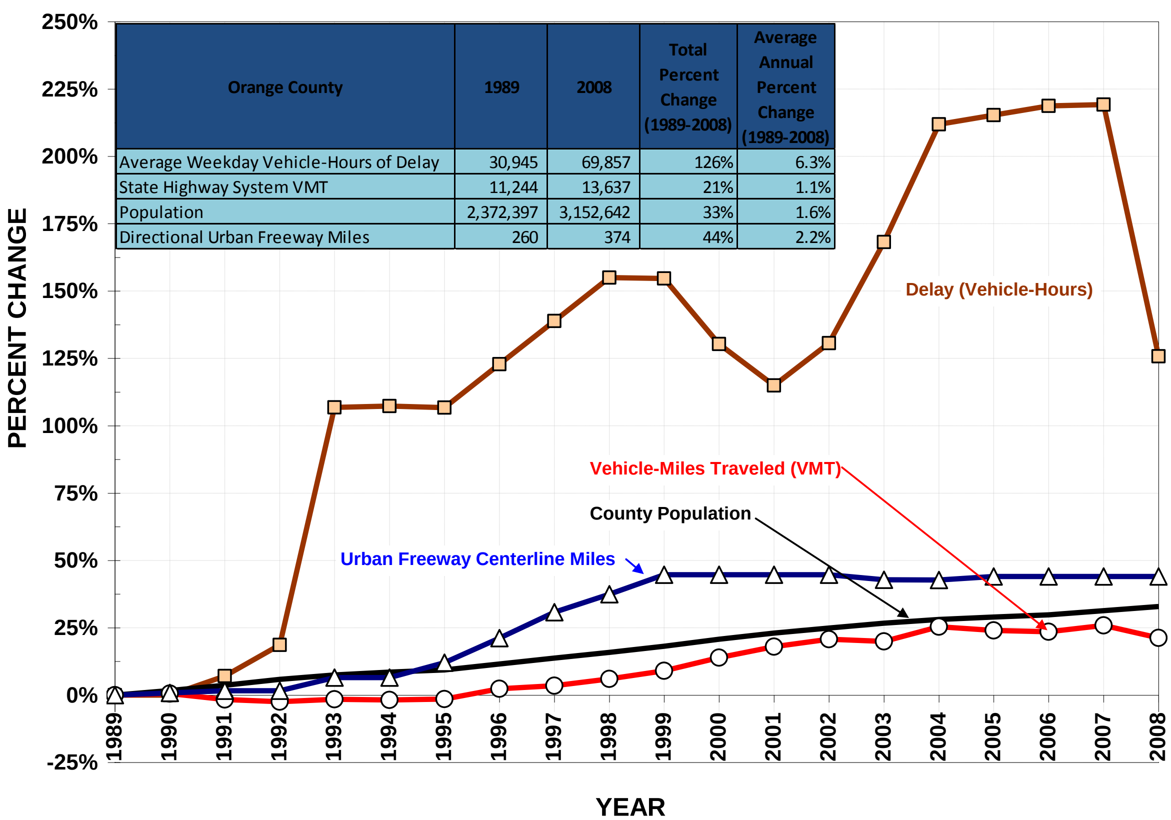
- Congestion, as measured by vehicle hours of delay increased by more than 125 percent from 1989 levels (just over four percent per year).
- Excluding the sharp decline in 2008, congestion had actually increased by more than 200 percent.

- While congestion rose by more than 125 percent, VMT and population rose by 21 percent and 33 percent, respectively.

- Urban freeway miles grew by less than 50 percent, but mostly between 1989 and 1999.

Clearly, further infrastructure expansion is not likely to keep pace with demographic and travel trends in the future. Therefore, if conditions are to improve, or at least not deteriorate as fast, a complementary approach to transportation decision making and investment is needed.

Exhibit 1-1: District 12 (Orange County) Growth Trends 1989-2008



Orange County	1989	2008	Total Percent Change (1989-2008)	Average Annual Percent Change (1989-2008)
Average Weekday Vehicle-Hours of Delay	30,945	69,857	126%	6.3%
State Highway System VMT	11,244	13,637	21%	1.1%
Population	2,372,397	3,152,642	33%	1.6%
Directional Urban Freeway Miles	260	374	44%	2.2%

Source: 1989 - 2008 HICOMP Reports

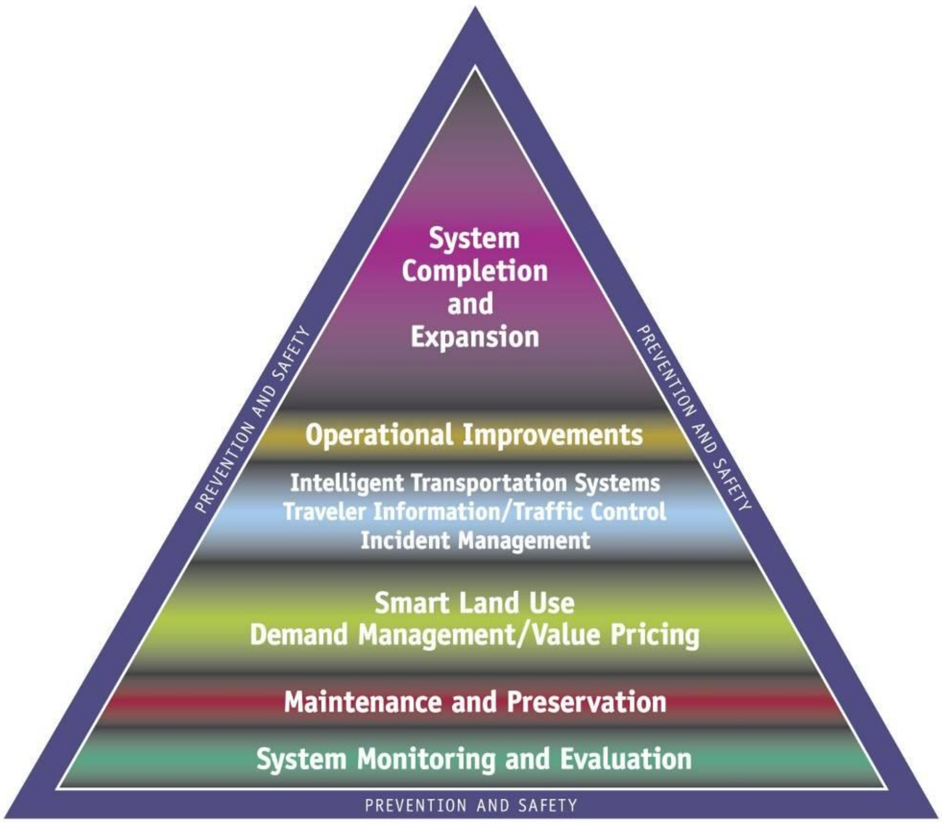
Caltrans recognizes this dilemma and has adopted a mission statement that embraces the concept of system management. This mission and its goals are supported by the approach illustrated in the System Management pyramid shown in Exhibit 1-2.

System Management is being touted at the federal, state, regional and local levels. It addresses both transportation demand and supply to get the best system performance possible. Ideally, Caltrans would develop a comprehensive regional system management plan that addresses all components of the pyramid for an entire region.

However, because system management is relatively new, it is prudent to apply it at the corridor level first.

The foundation of system management is monitoring and evaluation (shown as the base of the pyramid). This monitoring is done by comprehensive performance assessment and evaluation. Understanding how a corridor performs and why it performs the way it does is critical to crafting appropriate strategies. Section 3 of this report is dedicated to performance assessment. It is desirable for Caltrans to update this performance assessment every two or three years to ensure that future corridor issues can be identified and addressed before breakdown occurs on the corridor.

Exhibit 1-2: System Management Pyramid

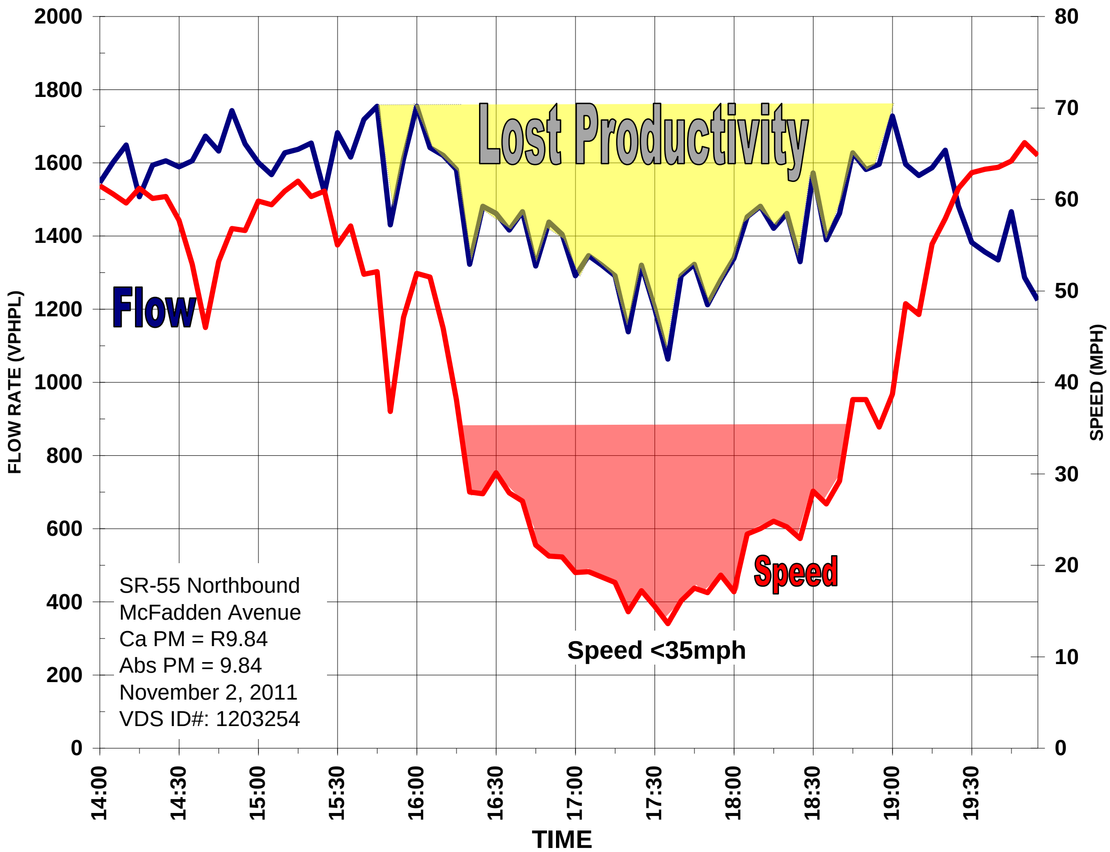


Source: Caltrans

A critical goal of system management is to “get the most out” of the existing system, or maximize system productivity. One would think that a given freeway is most productive during peak commute times. Yet, this is not true for heavy commute corridors. In fact, for Orange County’s urban freeways that experience growing congestion, the opposite is true. When demand is the highest, the flow breaks down and productivity, also known as vehicle throughput, declines.

Exhibit 1-3 illustrates how congestion leads to lost productivity. The exhibit was created using observed SR-55 data from automatic detectors for a typical afternoon peak period in late 2011. It shows speeds (in red) and flow rates (in blue) on northbound SR-55 at the McFadden Avenue interchange, one of the congested locations on this corridor.

Exhibit 1-3: Productivity Loss During Congestion (2011)



Source: Caltrans detector data

Flow rates (measured as vehicle-per-hour-per-lane or "vphpl") at the McFadden Avenue interchange average approximately 1,700 vphpl between 3:00 PM and 4:00 PM, which is slightly less than a typical peak period maximum flow rate.

Once volumes exceed this maximum rate, traffic breaks down and speeds plummet to below 35 miles per hour (mph). Rather than being able to accommodate the same number of vehicles, flow rates also drop and vehicles back up, creating congestion. At the location shown in Exhibit 1-3, vehicle throughput drops by 35 percent during the peak period (from around 1,700 to around 1,100 vphpl). This five-lane road therefore operates as if it has lost two lanes when demand is at its highest. Stated differently, just when the corridor needed the most capacity, it performed in the least productive manner and effectively lost lane capacities. This is a major cost of congestion that is rarely discussed and understood.

This is lost productivity. Where there is sufficient automatic detection, this loss in throughput can be quantified and presented as “Equivalent Lost Lane-Miles”. Discussed in more detail later in this report, the productivity losses on northbound SR-55 were almost four daily lane-miles during the PM peak period in 2010. Caltrans works hard to recover this lost productivity by investing in improvements that utilize public funds in the most effective manner. By largely implementing operational strategies, Caltrans can leverage past investments and restore productivity.

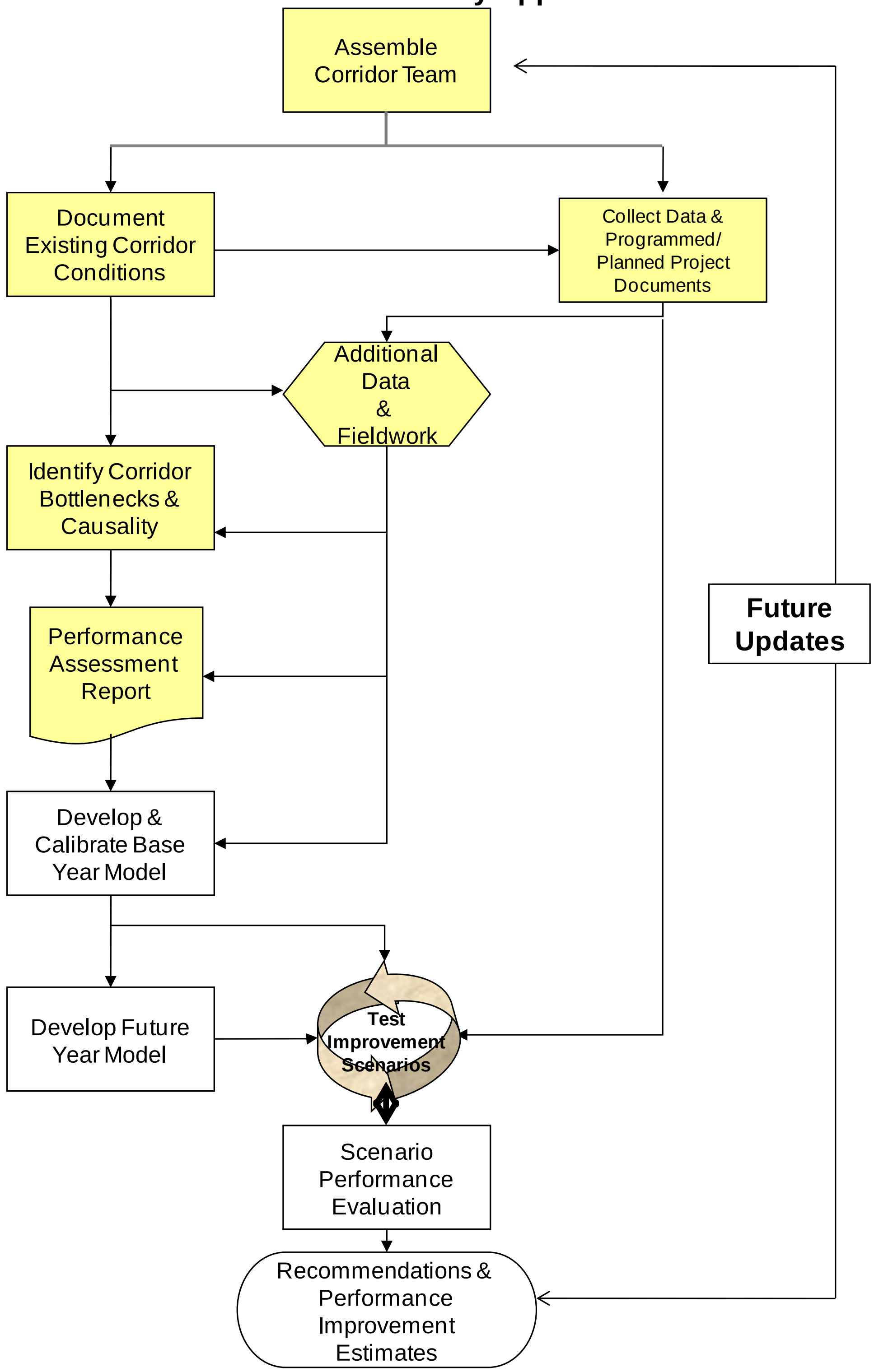
Although still an important strategy, infrastructure expansion (at the top of the pyramid in Exhibit 1-2) cannot be the only strategy to address mobility needs in Orange County. System management must be an important consideration as Caltrans and its partners evaluate the need for facility expansion. The system management philosophy begins by defining how the system is performing, understanding why it is performing that way, and then evaluating different strategies, including operations centric approaches to address deficiencies. Various tools can be used to estimate potential benefits to determine if these benefits are worthy of the costs to implement the strategy.

Study Approach

The SR-55 CSMP study approach follows system management principles by placing an emphasis on performance monitoring and evaluation (the base of the pyramid in Exhibit 1-2), and on using lower cost operational improvements to maintain system productivity.

Exhibit 1-4 is a flow chart that illustrates this approach, with the yellow shading indicating the steps which have been completed to date. Each step of the approach is described following the chart.

Exhibit 1-4: Study Approach



Document Existing Conditions

As part of this step, the study team evaluated the performance of the corridor by focusing on the four key areas of mobility, reliability, safety, and productivity. Using various sources of data, including automatic detector data, the existing conditions of the corridor were documented in order to better understand how it performs. The study team also compiled information relevant to traffic patterns along the corridor, such as traffic volumes, truck percentages, transit options, and major trip generators near SR-55.

Collect Data Programmed/Planned Project Information

The study team reviewed existing studies, plans, and other programming documents to assess additional data collection needs for modeling and future scenario development.

Additional Data Collection and Fieldwork

The study team determined locations where additional manual traffic counts would be needed to calibrate the 2011 Base Year model and coordinated the collection of this data. Traffic data counts collected included peak period turning movement counts, 24-hour average daily traffic (ADT) counts, and peak period connector counts. Additionally, signal timing data, ramp metering data, and recently collected traffic count data were obtained from Caltrans and the study team for use in the model calibration.

The study team conducted extensive field visits in November and December 2011 and January 2012 to observe field conditions during peak periods. In addition, field visits were conducted in August 2012 to evaluate beach traffic to Costa Mesa in the southbound direction. This fieldwork is discussed in Section 4: Bottleneck Identification and Causality Analysis.

Identify Corridor Bottlenecks and Causality

Building on the corridor performance evaluation and fieldwork, the study team identified major AM and PM peak period bottlenecks along the corridor. These bottlenecks will be discussed in detail in Section 4 of this report.

Performance Assessment Report

This document represents the Performance Assessment, which compiles all of the analysis conducted in the previous steps. It includes the corridor performance results for four years (2008, 2009, 2010, and 2011) and the identification of bottlenecks and their causes along the corridor. This report also includes performance results for each individual bottleneck area (i.e., segment between major bottleneck locations).

Develop and Calibrate Base Year Model

Using the bottleneck areas as the basis for calibration, the modeling team will develop a calibrated 2011 Base Year micro-simulation model for the corridor. This model will be calibrated against California and Federal Highway Administration (FHWA) guidelines for micro-simulation model calibration. In addition, the model will be evaluated to ensure that each bottleneck area was represented and that travel times and speeds are consistent with observed data.

Develop Future Year Model

Following the approval of the 2011 Base Year model, the modeling team will develop a 2023 Horizon Year model to be used to test the impacts of short-term programmed projects as well as future operational improvements, including the impacts of enhanced incident management on the corridor. Projects that are expected to be delivered well beyond 2023 will not be tested in the model.

Test Improvement Scenarios

The study team will develop scenarios to be evaluated using the micro-simulation model. Short-term scenarios will include programmed projects that would likely be completed within the next five years along with other operational improvements such as improved ramp metering.

In addition to the short-term evaluations, short-term projects will also be tested using the 2023 Horizon Year model to assess their long-term impacts. These scenarios will likely include programmed and planned projects that are not expected to be completed within five years of 2011 and that would likely only experience benefits in the long-term.

Scenario Performance Evaluations

Once scenarios are developed and fully tested, simulation results for each scenario will be subjected to a benefit-cost evaluation to determine how much return on investment each scenario will deliver. This detailed benefit-cost assessment will be performed using the California Benefit-Cost model (Cal-B/C).

Recommendations and Performance Improvement Estimates

The study team expects to develop final recommendations for future operational improvements that could be reasonably expected to maintain the mobility gains achieved by existing programmed and planned projects.

This report is organized into seven sections, including the Introduction. The remainder of this report is organized into six subsequent sections:

1. *Introduction*

2. *Corridor Description* describes the corridor, including the roadway facility, recent improvements, major interchanges and relative demands at these interchanges, relevant transit services serving freeway travelers, major Intermodal facilities around the corridor, special event facilities/trip generators, corridor socio-economic characteristics, and an SR-55 origin-destination demand profile from the Orange County Transportation Authority Orange County Transportation Analysis Model (OCTAM).

3. *Corridor-wide Performance and Trends* presents multiple years (2008 to 2011) of performance data for the freeway portion of the SR-55 corridor. Statistics are included for the mobility, reliability, safety, and productivity performance measures.

4. *Bottleneck Identification and Performance Assessment* describes how bottlenecks, or choke points, on the freeway facility were identified. These bottlenecks are generally the major cause for mobility and productivity performance degradations and are often related to safety issues as well. This section reports performance results for delay, productivity, and safety by major "bottleneck area". This performance assessment allows bottlenecks to be prioritized in terms of their contribution to corridor performance degradation.

5. *Bottleneck Causality Analysis* diagnoses the bottlenecks identified in Section 4 and identifies the causes of each bottleneck through additional data analysis and significant field observations. Electronic videos were taken for many of the major bottlenecks (to the extent possible) to verify our conclusions. Sections 4 and 5

will provide valuable input in selecting projects to address critical bottlenecks. Moreover, they provide the baseline against which the micro-simulation models will be validated.

6. *Scenario Development and Micro-Simulation* describes the scenario development approach and summarizes the expected future performance based on the Paramics micro-simulation model developed by the modeling team for the corridor.

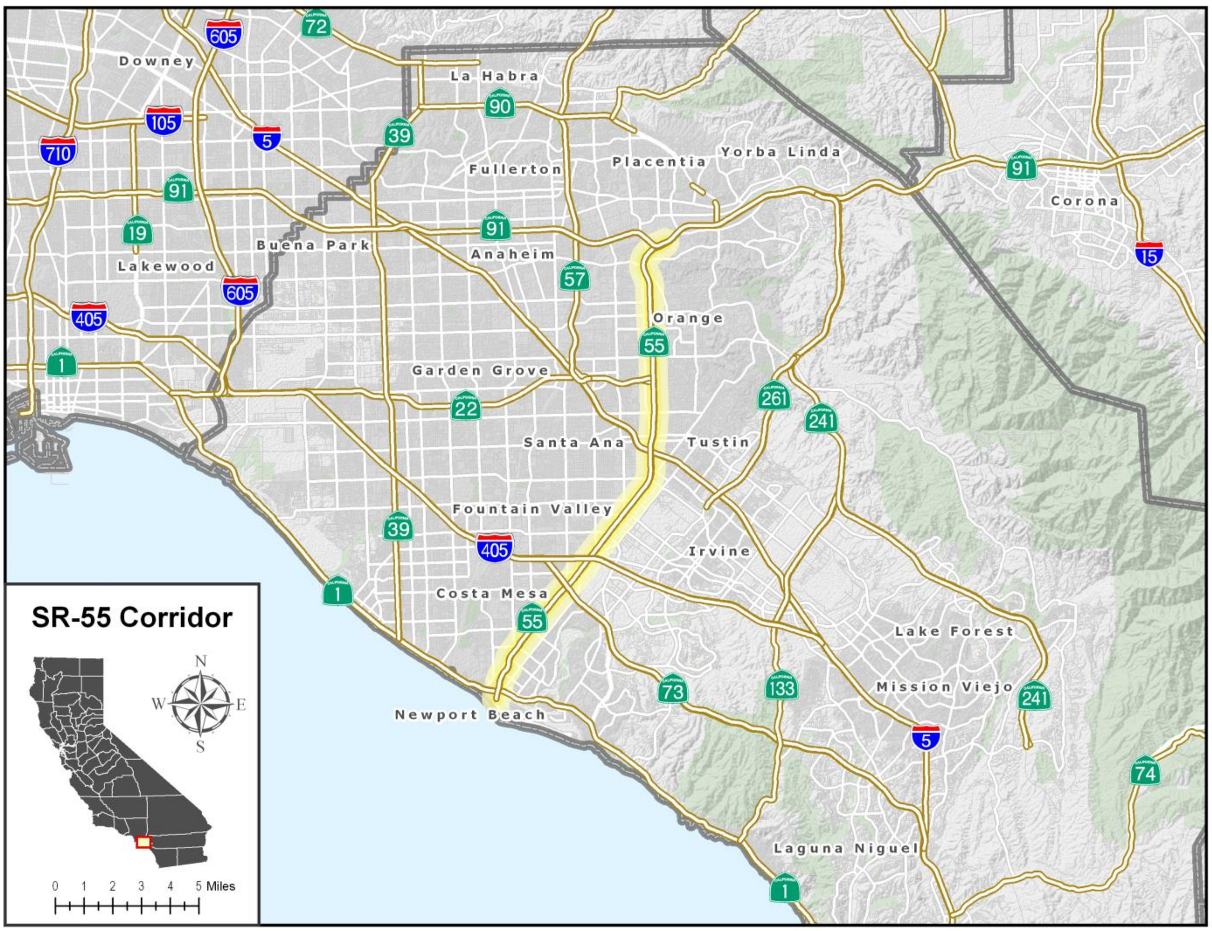
7. *Conclusions and Recommendations* describes the projects and scenarios that were evaluated and recommends a phased implementation of the most promising set of strategies.

The appendices provide a supplemental analysis conducted for summer midday congestion, project lists for the micro-simulation scenarios, and detailed benefit-cost results

2. CORRIDOR DESCRIPTION

As shown in Exhibit 2-1, the SR-55 study corridor, also known as the Costa Mesa Freeway, is a north-south state route that travels from the City of Newport Beach in the south (PM 0.0) to the Riverside Freeway (SR-91) interchange in the north (PM 17.876). It is the main route connecting northern and central Orange County to the coastal communities of Huntington Beach, Newport Beach, and Corona Del Mar. SR-55 from Finley Avenue to 19th Street is part of the local arterial system while SR-55 from 19th Street to SR-91 is part of the freeway system.

Exhibit 2-1: Orange County SR-55 CSMP Corridor Map



Source: SMG

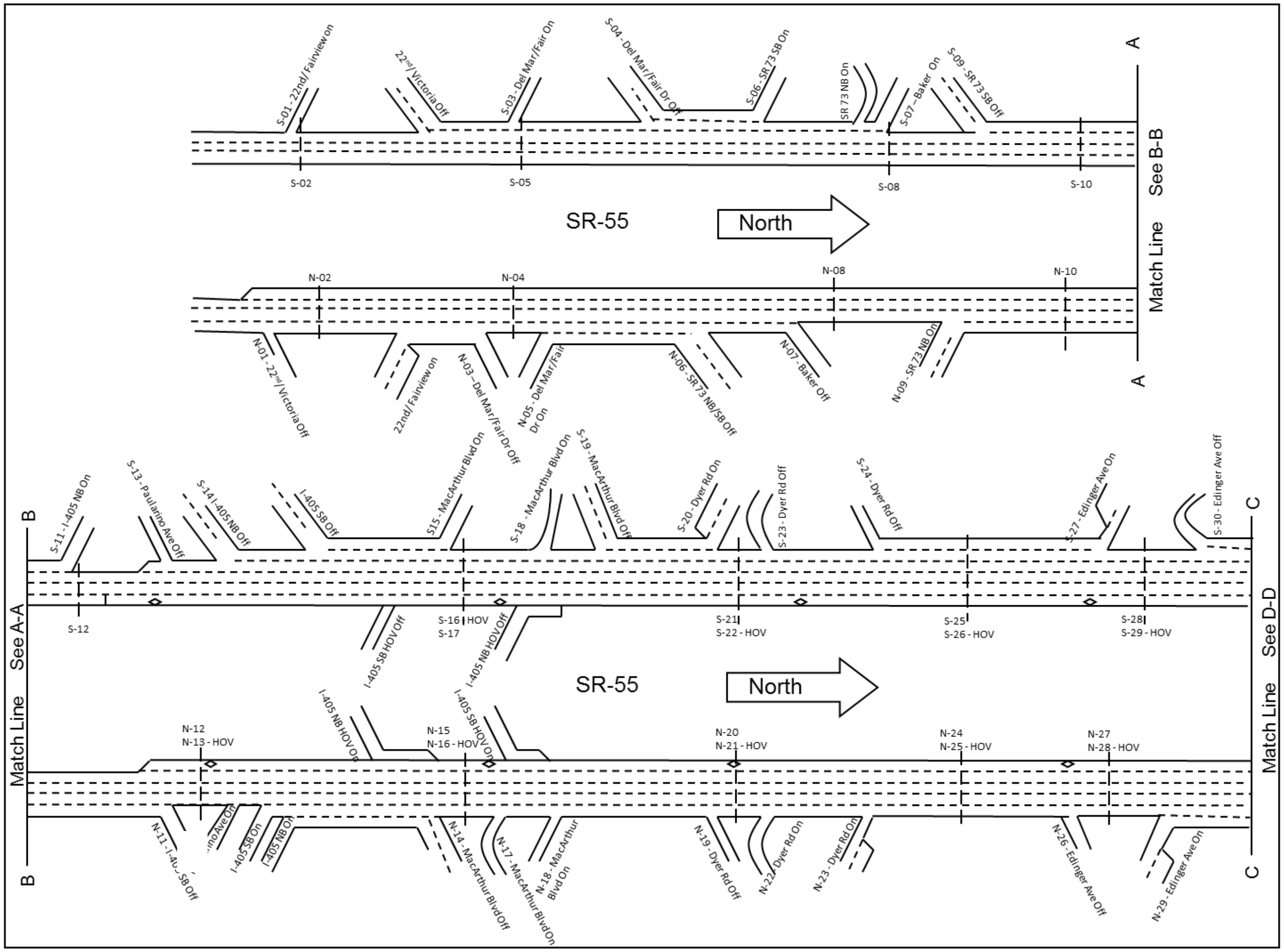
Corridor Roadway Facility

The study corridor traverses through the cities of Orange, Anaheim, Tustin, Santa Ana, Costa Mesa, and Newport Beach. Major interchanges in this study corridor include the following:

- SR-91 is a major east-west corridor in the county and links Riverside and San Bernardino Counties to Orange and Los Angeles Counties.
- SR-22 is also an east-west route in the county and is 13 miles long, stretching from the City of Seal Beach in the west to the City of Orange in the east.
- I-5 is a major north-south route that runs throughout the state. It connects Orange County with Los Angeles County on the north end and with San Diego County on the south end. It intersects the SR-55 corridor in the City of Tustin.
- I-405 begins at the I-5 interchange (the El Toro Y) in Irvine and runs in a northwest direction, parallel to the ocean until it terminates and connects back to I-5 in the San Fernando Valley.
- SR-73 connects the I-5 corridor in San Juan Capistrano to the I-405 corridor in Costa Mesa. It runs through Crystal Cove State Park and the University of California at Irvine. From the northern terminus, the first three miles of SR-73 are called the Corona del Mar Freeway. The next 12 miles of the highway operate as a toll road, called the San Joaquin Hills Transportation Corridor.
- SR-1 connects to SR-55 at the southern end of the corridor. It provides coastal access near Dana Point in Orange County along the coast to Mendocino County.

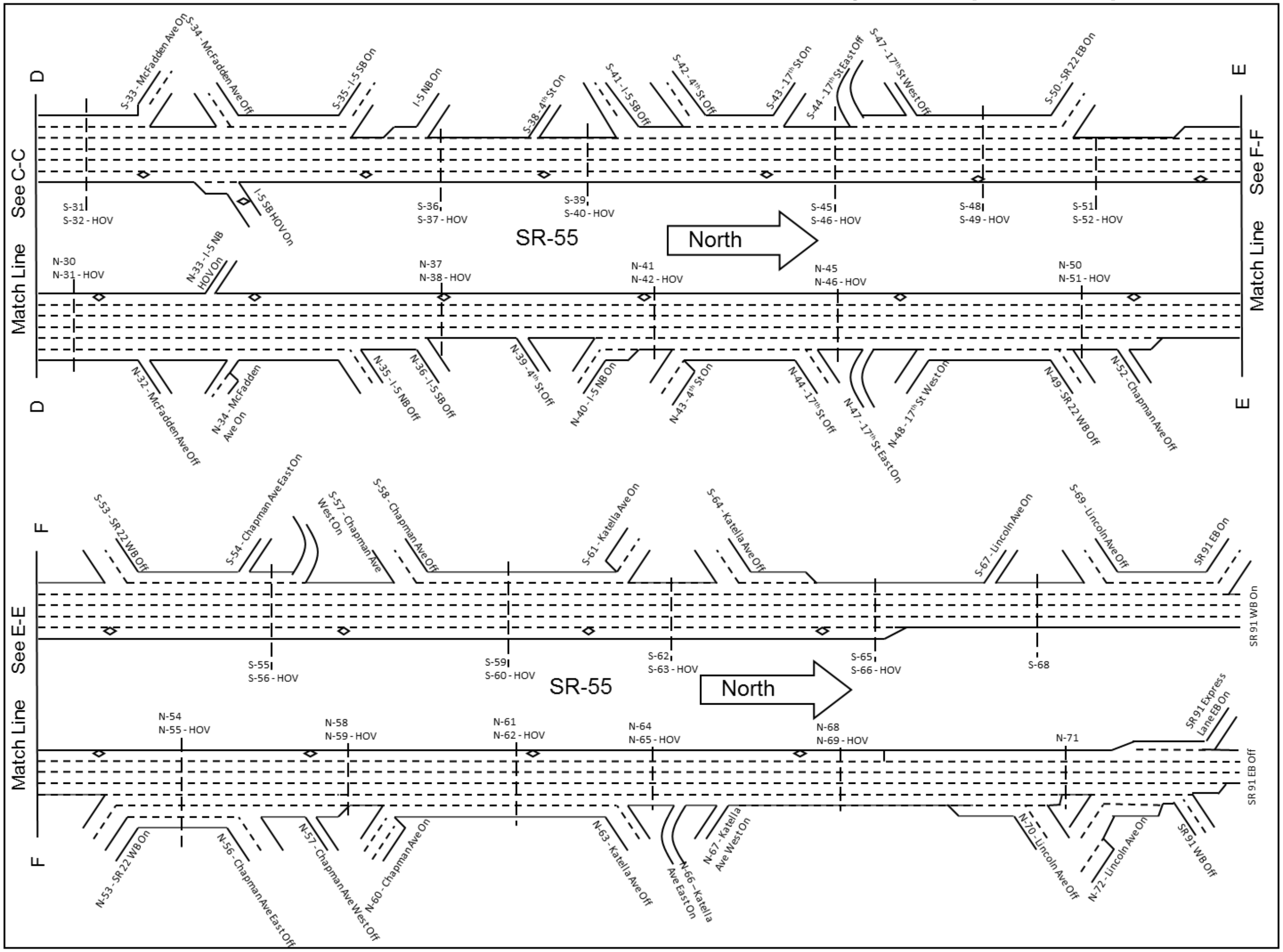
As depicted in Exhibit 2-2, SR-55 from SR-91 to the City of Newport Beach generally has four through travel lanes in each direction of travel. Ramp meters are active during both the morning and afternoon peak periods. Both inside and outside shoulders are at least eight feet in width with a divided median. An HOV lane in each direction runs approximately 10 miles of the length of the corridor. Exhibits 2-3 and 2-4 show the northbound and southbound average weekday (Tuesday through Thursday) AM and PM peak hour volumes for February 2011 and annual average daily traffic (AADT) for the corresponding segments shown in Exhibit 2-2.

Exhibit 2-2: SR-55 Corridor Lane Configuration



Source: Based on Google Earth

Exhibit 2-2: SR-55 Corridor Lane Configuration (continued)



Source: Based on Google Earth

Exhibit 2-3: Northbound SR-55 2011 Peak Hour/AADT Volumes

Segment No.	Description	AM Pk Hr	PM Pk Hr	AADT
N-01	22nd/Victoria Off	61	110	1,148
N-02	Mainline	3,766	3,056	48,445
N-03	Del Mar/Fair Dr Off	256	236	2,859
N-04	Mainline	5,593	3,822	63,392
N-05	Del Mar/Fair Dr On	1,546	997	17,656
N-06	SR73 NB/SB Off	2,563	2,085	27,731
N-07	Baker Off	660	414	4,225
N-08	Mainline	3,913	2,269	48,874
N-09	SR73 NB On	2,086	1,182	20,305
N-10	Mainline	6,103	3,486	70,299
N-11	I-405 SB Off	636	655	7,939
N-12	Mainline	6,957	2,872	77,852
N-13	HOV	492	705	n/a
N-14	MacArthur Blvd Off	1,671	976	12,775
N-15	Mainline	7,351	3,234	91,849
N-16	HOV	193	280	4,593
N-17	MacArthur Blvd On	609	650	8,966
N-18	MacArthur Blvd On	224	830	6,349
N-19	Dyer Rd Off	1,094	197	8,529
N-20	Mainline	7,183	4,463	98,816
N-21	HOV	535	747	7,433
N-22	Dyer Rd On	703	1,192	12,341
N-23	Dyer Rd On	368	895	8,468
N-24	Mainline	7,990	5,881	111,541
N-25	HOV	809	1,471	n/a
N-26	Edinger Ave Off	550	128	5,031
N-27	Mainline	7,462	5,697	108,188
N-28	HOV	787	1,546	16,266
N-29	Edinger Ave On	862	1,580	13,578
N-30	Mainline	8,075	7,090	116,956
N-31	HOV	765	1,701	16,629
N-32	McFadden Ave Off	255	209	4,521
N-33	I-5 NB HOV On	347	902	16,926
N-34	McFadden Ave On	652	937	10,217
N-35	I-5 NB Off	3,480	2,537	48,387
N-36	I-5 SB Off	742	515	12,079
N-37	Mainline	4,655	4,743	55,331
N-38	HOV	299	993	17,554
N-39	4th St Off	799	541	7,531
N-40	I-5 NB On	1,987	2,538	34,035
N-41	Mainline	3,957	4,333	58,832
N-42	HOV	278	981	7,440
N-43	4th St On	801	1,110	9,980
N-44	17th St Off	735	650	11,468
N-45	Mainline	7,962	9,068	105,120
N-46	HOV	874	1,710	11,658
N-47	17th St East On	264	719	5,661
N-48	17th St West On	697	831	n/a
N-49	SR 22 WB Off	4,468	4,853	85,687
N-50	Mainline	5,076	6,058	74,308
N-51	HOV	272	1,020	8,240
N-52	Chapman Ave Off	484	767	9,187
N-53	SR 22 WB On	1,408	2,235	43,100
N-54	Mainline	4,114	4,994	68,573
N-55	HOV	270	999	8,239
N-56	Chapman Ave East Off	661	1,138	n/a
N-57	Chapman Ave West Off	1,176	1,264	n/a
N-58	Mainline	5,679	7,315	n/a
N-59	HOV	501	735	n/a
N-60	Chapman Ave On	2,271	2,760	n/a
N-61	Mainline	6,582	8,678	108,194
N-62	HOV	359	1,186	10,405
N-63	Katella Ave Off	1,162	1,798	20,664
N-64	Mainline	5,398	6,838	86,945
N-65	HOV	367	1,180	10,530
N-66	Katella Ave East On	293	586	n/a
N-67	Katella Ave West On	533	325	n/a
N-68	Mainline	6,109	7,626	97,180
N-69	HOV	368	1,171	10,567
N-70	Lincoln Ave Off	525	1,123	10,518
N-71	Mainline	6,333	7,526	94,877
N-72	Lincoln Ave On	472	352	n/a

n/a: not available

Source: Caltrans detector data

Exhibit 2-4: Southbound SR-55 2011 Peak Hour/AADT Volumes

Segment No.	Description	AM Pk Hr	PM Pk Hr	AADT
S-01	22nd/Fairview On	128	81	1,507
S-02	Mainline	3,062	3,325	44,504
S-03	Del Mar/Fair Dr On	239	240	3,368
S-04	Del Mar/Fair Dr Off	724	1,657	13,581
S-05	Mainline	3,798	5,507	62,863
S-06	SR73 SB On	820	1,167	n/a
S-07	Baker On	177	473	n/a
S-08	Mainline	2,976	4,760	51,367
S-09	SR 73 SB Off	2,611	1,849	22,708
S-10	Mainline	5,946	6,877	n/a
S-11	I-405 NB On	1,225	1,715	17,963
S-12	Mainline	3,449	3,770	51,096
S-13	Paularino Off	1,265	874	16,678
S-14	I-405 NB/SB Off	1,948	2,359	n/a
S-15	MacArthur Blvd On	630	812	n/a
S-16	HOV	1,041	1,179	11,660
S-17	Mainline	6,999	7,475	103,506
S-18	MacArthur Blvd On	138	571	n/a
S-19	MacArthur Blvd OFF	444	100	n/a
S-20	Dyer Rd On	575	768	8,059
S-21	Mainline	7,517	6,630	103,768
S-22	HOV	1,072	1,105	11,451
S-23	Dyer Rd Off	415	249	8,329
S-24	Dyer Rd Off	513	401	8,443
S-25	Mainline	8,692	7,753	123,159
S-26	HOV	1,352	1,253	16,424
S-27	Edinger Ave On	562	694	6,695
S-28	Mainline	7,793	6,758	116,584
S-29	HOV	1,446	1,282	14,623
S-30	Edinger Ave Off	639	485	9,077
S-31	Mainline	7,795	6,939	115,725
S-32	HOV	1,626	1,322	16,624
S-33	McFadden Ave On	636	383	5,831
S-34	McFadden Ave Off	249	406	6,848

Segment No.	Description	AM Pk Hr	PM Pk Hr	AADT
S-35	I-5 SB On	2,972	2,789	50,190
S-36	Mainline	4,117	4,052	58,531
S-37	HOV	988	693	8,094
S-38	4th St On	574	539	4,524
S-39	Mainline	3,575	3,613	54,500
S-40	HOV	1,025	649	7,840
S-41	I-5 SB Off	1,538	1,686	37,460
S-42	4th St Off	1,767	3,131	n/a
S-43	17th St On	1,194	1,003	13,502
S-44	17th St East Off	848	772	6,689
S-45	Mainline	5,342	6,744	87,821
S-46	HOV	1,083	679	7,852
S-47	17th St West Off	589	415	6,079
S-48	Mainline	6,559	7,943	98,941
S-49	HOV	1,224	689	8,056
S-50	SR 22 EB On	2,526	2,480	20,873
S-51	Mainline	4,228	5,328	77,322
S-52	HOV	1,162	649	7,784
S-53	SR22 WB Off	2,483	2,101	38,226
S-54	Chapman Ave East On	558	622	7,951
S-55	Mainline	6,364	7,367	106,482
S-56	HOV	1,075	535	7,250
S-57	Chapman Ave West On	1,261	1,028	n/a
S-58	Chapman Ave Off	1,135	915	11,064
S-59	Mainline	6,051	6,240	90,186
S-60	HOV	1,304	1,773	20,746
S-61	Katella Ave On	654	788	n/a
S-62	Mainline	5,840	6,500	89,327
S-63	HOV	1,010	458	6,769
S-64	Katella Ave Off	874	805	10,504
S-65	Mainline	5,702	6,768	92,527
S-66	HOV	925	421	6,255
S-67	Lincoln Ave On	695	829	11,033
S-68	Mainline	6,247	6,574	90,437
S-69	Lincoln Ave Off	650	635	9,209

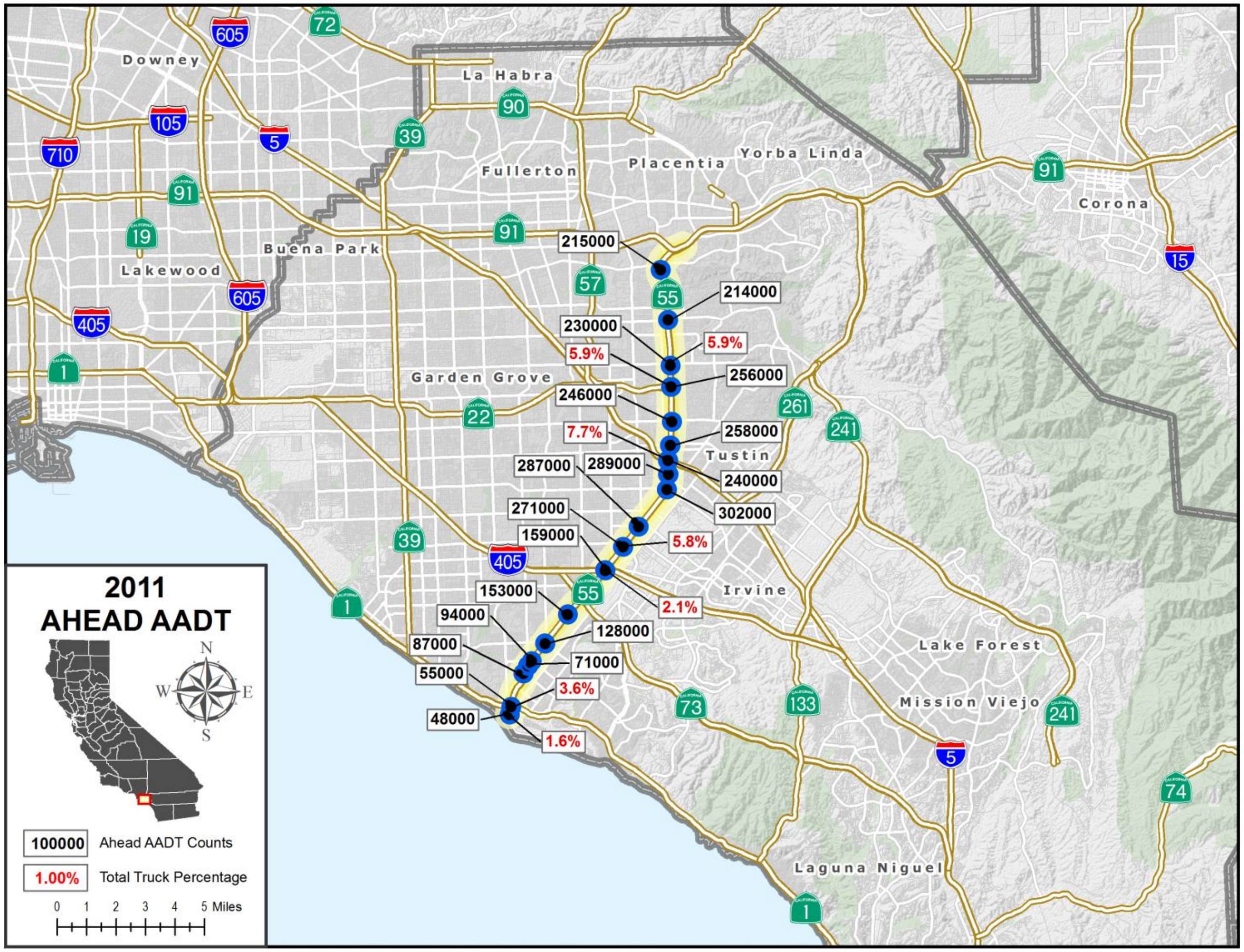
n/a: not available

Source: Caltrans detector data

According to the Caltrans Traffic and Vehicle Data Systems annual traffic volumes report for 2011, Orange County SR-55 carries between 48,000 and 302,000 annual average daily traffic (AADT) as shown in Exhibit 2-5. The highest average daily traffic volume on the corridor occurs at the Edinger Avenue interchange.

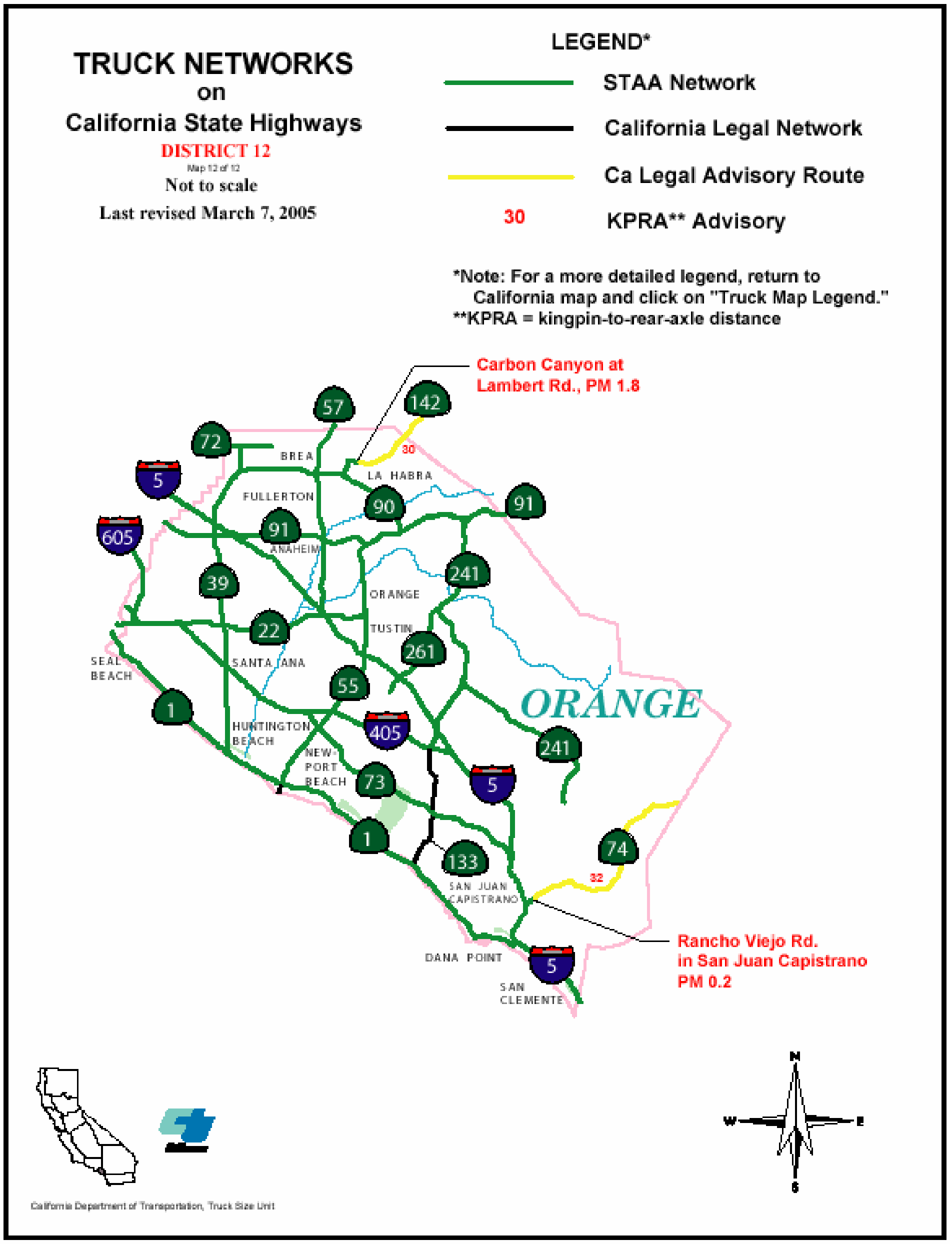
SR-55 is designated as a Surface Transportation Assistance Act (STAA) route shown in Exhibit 2-6, which means that trucks are allowed to operate on the corridor. According to the latest truck volumes from the 2010 Caltrans Annual Average Daily Truck Traffic data, trucks comprise between 1.6 and 7.7 percent of total daily traffic along the corridor. The highest truck volumes occur at the I-5 interchange.

Exhibit 2-5: 2011 Annual Average Daily Traffic Volumes and Truck Percentage on SR-55



Source: Caltrans Traffic and Vehicle Data Systems

Exhibit 2-6: Orange County Truck Network on California State Highways



Source: Caltrans Truck Network Map

Corridor Transit Services

Three major public transportation operators provide service near the study corridor:

- Southern California Regional Rail Authority (SCRRA) – Metrolink
- Amtrak Pacific Surfliner and Southwest Chief train service
- Orange County Transportation Authority (OCTA).

SCRRA is a joint powers authority that operates the Metrolink regional rail service throughout Southern California. Metrolink commuter rail service stops at 11 stations in Orange County and provides 44 weekday roundtrips on three lines:

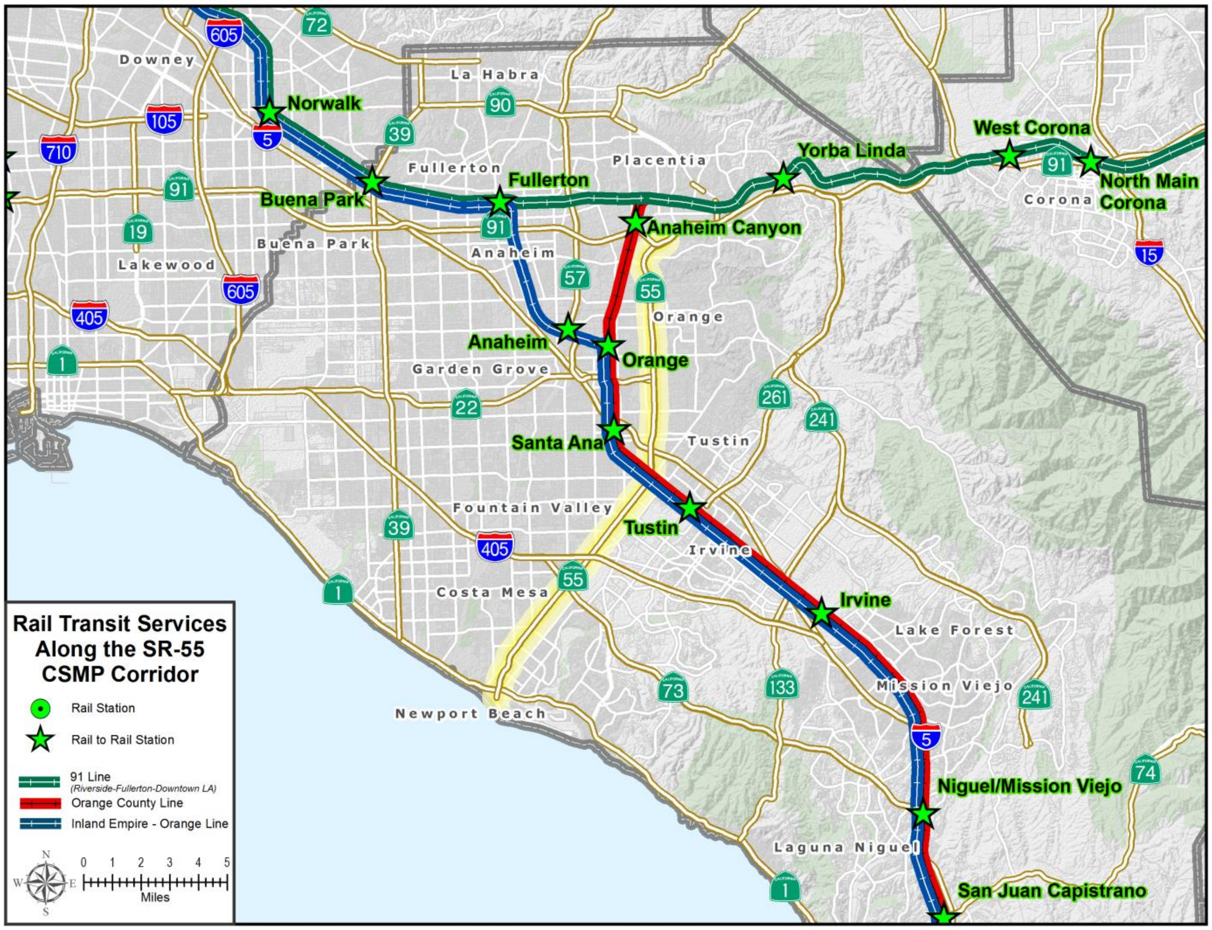
- The Orange County Line provides service from Los Angeles Union Station to Oceanside.
- The Inland Empire-Orange County Line provides service from San Bernardino to Oceanside.
- The 91 Line provides service from Riverside to Los Angeles Union Station via Fullerton and Buena Park.

Amtrak Pacific Surfliner

While Metrolink provides intra-regional service throughout Southern California, Amtrak provides interregional service. Two Amtrak trains use the same route as Metrolink's trains. Amtrak's Pacific Surfliner, which offers service from San Diego to San Luis Obispo, travels along the same route as Metrolink's Orange County Line; and Amtrak's Southwest Chief, which offers service from Los Angeles to Chicago, travels along the same route as Metrolink's Inland Empire-Orange County Line.

Exhibit 2-7 shows the primary rail services offered by SCRRA and Amtrak near the study corridor.

Exhibit 2-7: Rail Transit Services near SR-55



Source: SCRRA and Amtrak

<u>Orange County Transportation Authority (OCTA)</u>

As the primary bus transit provider in Orange County, OCTA provides fixed-route bus and paratransit services throughout the county. In addition to local fixed routes and community and shuttle routes that run in the vicinity of SR-55 as shown in Exhibit 2-8, the following routes operate on the study corridor:

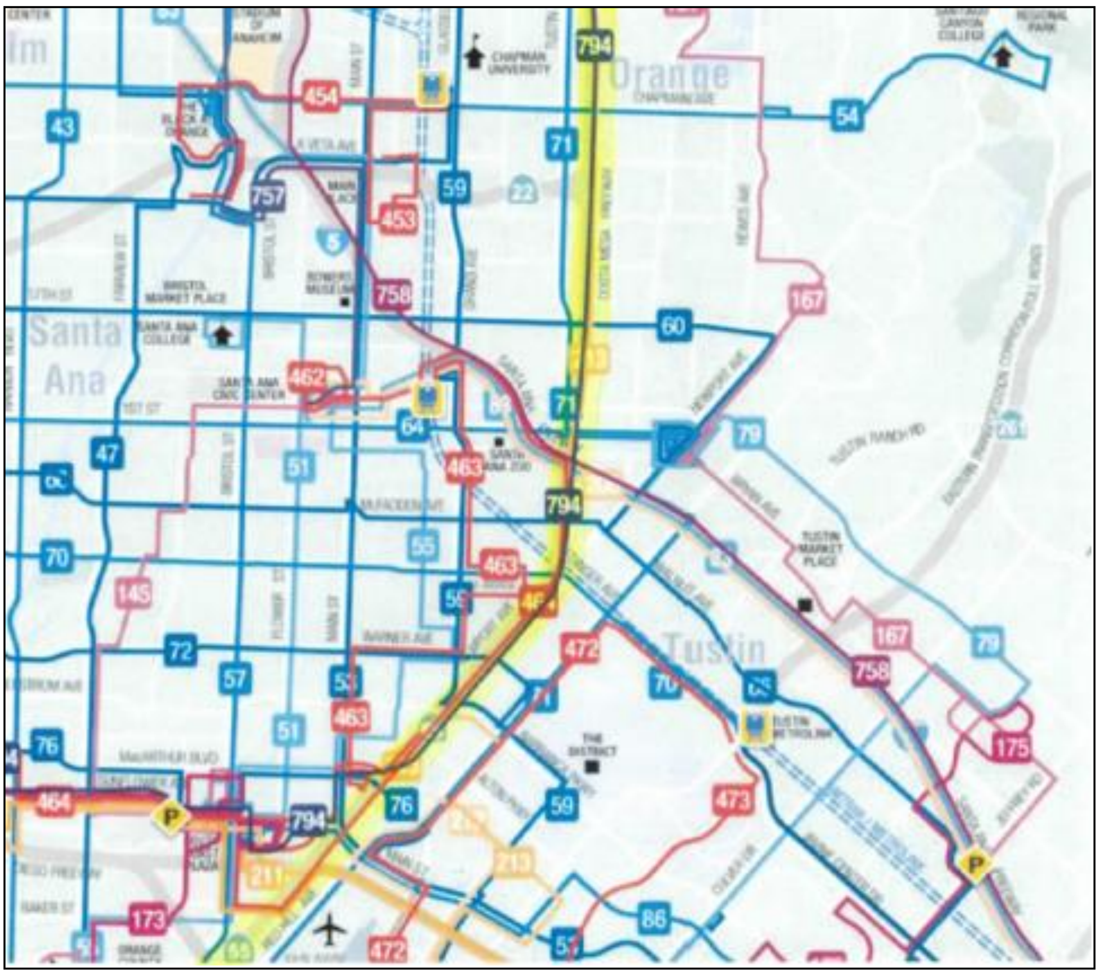
- Intracounty Express Route 213 provides weekday service from Brea to Irvine via the SR-55 freeway.
- Route 71 operates parallel to SR-55, providing frequent service between the cities of Newport Beach and Yorba Linda. This route stops in the cities of Costa Mesa, Irvine, Tustin, Santa Ana, Orange, Anaheim, and Placentia.

- Route 55 operates daily between the cities of Brea and Newport Beach via State College Boulevard. State College Boulevard is a four to six-lane arterial that runs parallel to SR-55 directly west of the corridor. The route begins at the Brea Mall and terminates at the Newport Transportation Center/Park-and-Ride facility, with various stops in the cities of Fullerton, Anaheim, Orange, Santa Ana, Costa Mesa, and Newport Beach.

- Route 464 provides weekday Metrolink feeder service from Costa Mesa to Santa Ana via the I-5/SR-55 freeways and Sunflower Avenue.

- Intercounty Express Route 794 provides weekday service from Riverside/Corona to South Coast Metro Express via the SR-91 and SR-55 freeways.

Exhibit 2-8: OCTA Bus Service along SR-55



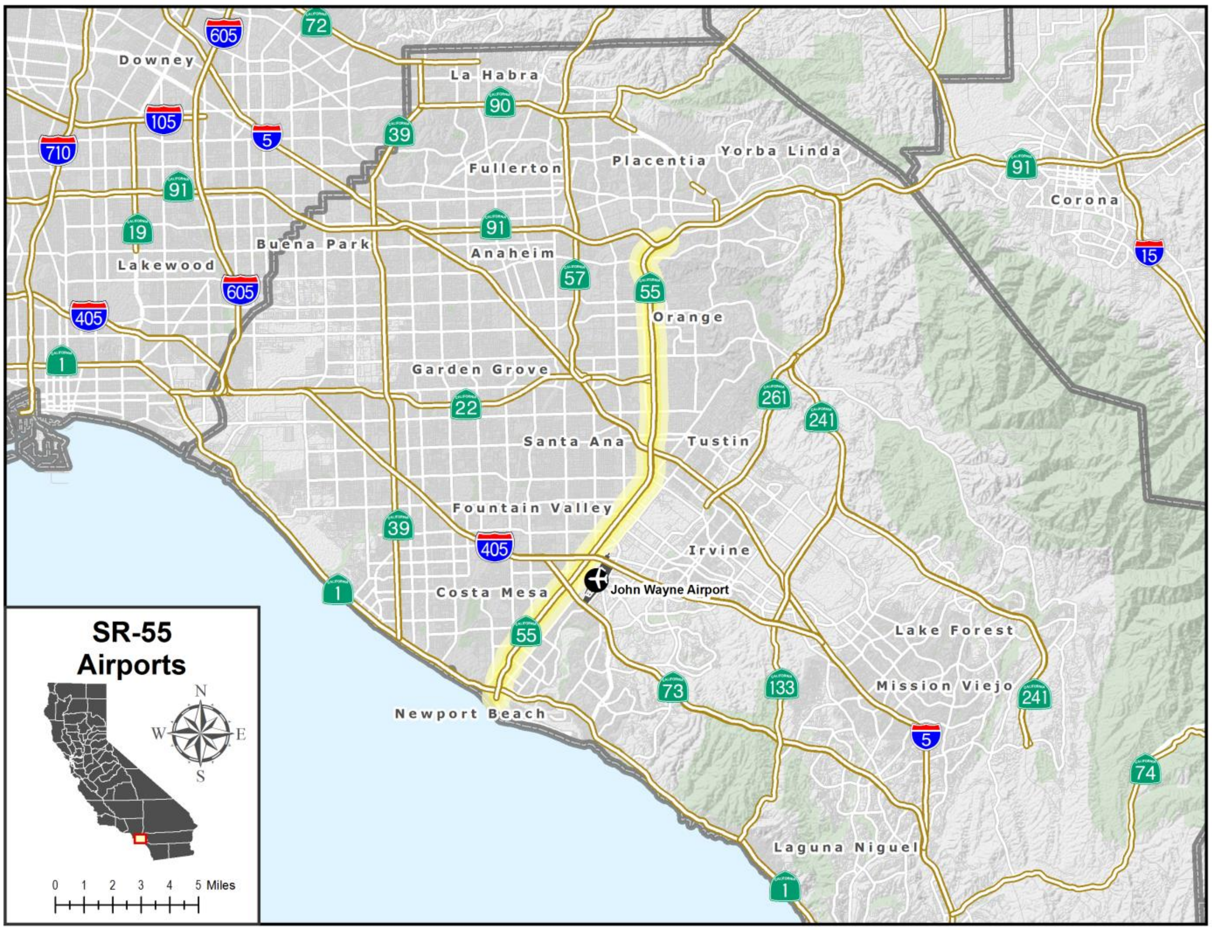
Source: OCTA

Intermodal Facilities

There are various intermodal facilities throughout the SR-55 study area, including one airport and various park and ride facilities.

John Wayne Airport (SNA) is immediately adjacent to the SR-55 corridor between the I-405 and SR-73 interchanges. Exhibit 2-9 shows the location of John Wayne Airport in relation to the SR-55 corridor.

Exhibit 2-9: Airport Facilities



Source: SMG/GIS/Internet

Exhibit 2-10 shows the John Wayne Airport annual passenger boarding statistics from 2003 to 2010. Ten commercial, two commuter and two all-cargo airlines operate at the airport. In addition to serving passengers, John Wayne Airport also handles more than 15,000 tons of cargo each year. It hosts air carrier, general aviation, air taxi, military, and air cargo services.

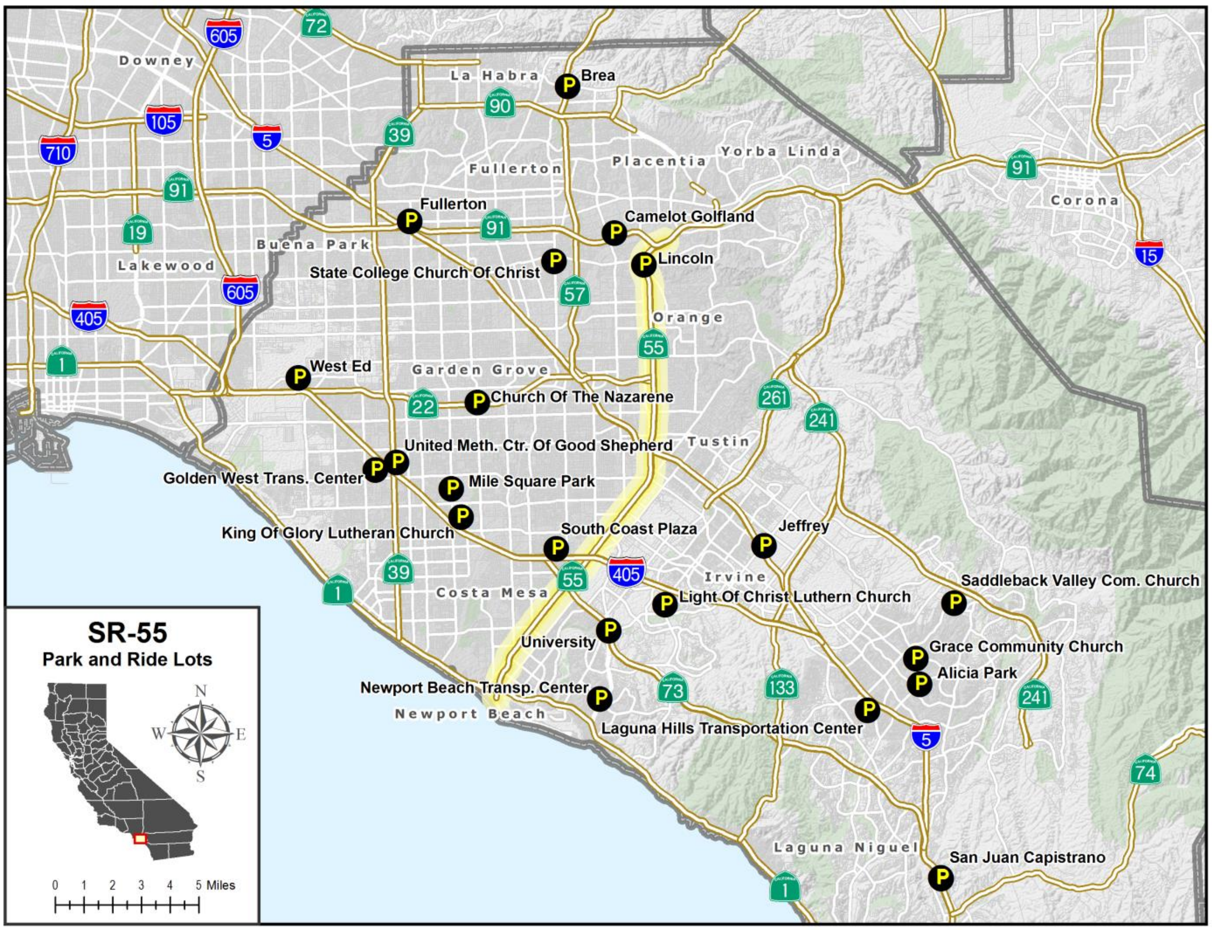
Exhibit 2-10: John Wayne Airport Passenger Boarding Statistics (2003-2010)

	2003	2004	2005	2006	2007	2008	2009	2010
Passenger Boardings	4,266,083	4,621,107	4,791,786	4,777,896	4,948,846	4,464,380	4,311,329	4,278,623
Difference		355,024	170,679	-13,890	170,950	-484,466	-153,051	-32,706
Percent Difference		8.3%	3.7%	-0.3%	3.6%	-9.8%	-3.4%	-0.8%

Source: Federal Aviation Administration (FAA) Air Carrier Activity Information System (ACAIS).

Several park and ride facilities are situated near the SR-55 study corridor, as shown in Exhibit 2-11. There are two facilities directly next to the corridor in the cities of Orange (at Lincoln) and Costa Mesa (at South Coast Plaza).

Exhibit 2-11: Park and Ride Facilities



Source: Caltrans

According to the Caltrans 2008 HOV Annual Report, the SR-55 Corridor has high HOV lane use with 1,810 vehicles per lane during the northbound PM peak hours and 1,564 vehicles per lane during the southbound AM peak hours at Warner Avenue. While carpools comprise up to 92.5 percent of the HOV lane users, motorcycles, low emission vehicles, vans, and buses also use the facility. Adjacent mainline lanes are mostly used by cars (over 90 percent) with smaller numbers of carpools, trucks, buses, motorcycles, and vans.

Special Event Facilities/Trip Generators

There are various facilities and institutions located along SR-55 that have the potential to generate significant trips on the corridor. Exhibit 2-12 shows the location of significant traffic generators.

John Wayne Airport (JWA) is a major trip generator for the Orange County area. It is the second largest airport by passenger volume in the area, including Los Angeles Airport, Ontario Airport, and Long Beach Airport. The SR-55 corridor is the main freeway access to John Wayne Airport. The MacArthur Boulevard interchange provides access via the freeway while local traffic can access the airport via many local arterials.

SR-55 is the main arterial connecting the Inland Empire Counties to central and south Orange County. It is also the main route to the beach areas and tourist attractions in the county's coastal communities. Besides heavy summer beach traffic, visitors also use SR-55 to access the beaches and special events and activities year round in the Orange County area.

SR-55 also serves as a major commute route for Orange County residents as well as residents from areas of Riverside and San Bernardino Counties due to the major employment centers located within central and southern Orange County.

The special event facilities located within several miles of the SR-55 corridor include:

- The Disneyland Resort and Theme Park is located about five miles west of SR-55. It is the second busiest amusement park in the world with an average daily attendance of nearly 40,000 patrons. The Disneyland Resort directly employs over 20,000 people, making it Orange County's largest employer and one of the largest single-site private employers in the state.
- Angel Stadium is home to the professional baseball team, the Los Angeles Angels of Anaheim. The stadium seats over 45,000 fans and is located less than three miles west of SR-55 off Katella Avenue.
- The Honda Center is home to the professional hockey team, the Anaheim Ducks. Other events such as concerts, rodeos, basketball tournaments, and major

performances take place at this venue. It is located less than three miles west of SR-55 off Katella Avenue.

- Orange County Fair & Events Center is located immediately adjacent to SR-55 southwest of the SR-55/SR-73 interchange. It provides educational, entertainment and recreational opportunities for the general public and preserves the heritage of California agriculture. It has weekday and weekend venues and includes the Pacific Amphitheater.
- Santa Ana Civic Center is Orange County's main center of government. It is located approximately two miles northwest of the I-5/SR-55 interchange. The Civic Center houses City Hall, the public library, police department, county jail, and city, state, and federal courthouses.

Universities and colleges can also generate significant trips. The following institutions are located near the study corridor:

- California State University Fullerton is situated approximately five miles northwest of the SR-55/SR-91 interchange. It is a four-year public university offering bachelors and masters degree programs with an enrollment of over 35,000 students.
- Chapman University is a private university located one mile west of SR-55 off Chapman Avenue. It is known for its blend of liberal arts and professional programs. Chapman University encompasses seven schools and colleges and enrolls more than 6,000 undergraduate, graduate and law students.
- Brandman University Irvine is part of the Chapman University System also located one mile west of SR-55 off Chapman Avenue. It is home to over 600 students as well as Brandman's administrative headquarters. It offers bachelors and masters degree programs and teaching credentials.
- Vanguard University is a private Christian university located southwest of the SR-55/SR-73 interchange in the city of Costa Mesa. It has an enrollment of approximately 2,000 students and offers four-year Bachelor of Arts or Science degrees in 30 majors and concentrations.
- Orange Coast College is a community college also located southwest of the SR-55/SR-73 interchange in the city of Costa Mesa. It offers more than 130 academic and career programs and has an enrollment of over 25,000 students. It ranks first out of Orange County's nine community colleges in the number of students it transfers to the University of California and California State University systems.
- Concordia University Irvine is a private Christian university located about four miles southeast of SR-55. It offers undergraduate, graduate, and adult degree programs and has an enrollment of over 3,300 students.

- Santa Ana College is a community college located over three miles west of SR-55 on 17th Street. It has an enrollment of over 18,000 students.
- Irvine Valley College is situated about 4.5 miles west of SR-55 off Edinger Avenue. It has an enrollment of over 15,000 students and offers associate degrees and occupational certificates.
- The University of California at Irvine (UCI) is located east of SR-55, between the SR-73 and I-405 corridors. This four-year public university enrolls almost 27,700 students and offers Bachelors, Masters, and Doctorates degree programs.

There are many medical facilities close to SR-55 that can generate significant trips:

- Kaiser Permanente Orange County Anaheim Medical Center is located north of SR-91between Tustin Avenue and Kraemer Boulevard/Glassell Street. It offers emergency services with departments and specialties in cardiology, neonatal intensive care unit (NICU), pediatrics, physical/occupational therapy, radiology, and social medicine. Kaiser Permanente Alton/Sand Canyon Medical Offices, located east of SR-55 near the I-405 freeway, also offers advice nurse, audiology, cardiology, and other specialty services.
- Chapman Medical Center is located just east of SR-55 off Chapman Avenue. It is a 114-bed acute care facility, which provides high-technology tertiary services in central Orange County. Basic services include a 24-hour emergency department, intensive care unit, medical/surgical unit, inpatient surgical services, outpatient surgical services. Signature services include Bloodless Medicine and Surgery Program, Center for Senior Mental Health Geriatric Psych Services, Chapman Spine and Orthopedic Institute, Chemical Dependency and Drug Addiction Services, Lap Band Surgery, Neurosurgical Spine Services, Positive Achievement Center, and Spine Surgery.
- Western Medical Center Santa Ana is located just west of SR-55 off 17th Street or 4th Street. It is an acute care hospital designated as a Level II trauma center and offers services in neurology, cardiology, trauma, emergency, burn services, rehabilitative care, and programs for seniors, women, and children.
- College Hospital Costa Mesa is located near the southern edge of SR-55. It is a 122-bed acute care hospital that offers medical/surgical services as well as a full spectrum of psychiatric services.
- Hoag Hospital Newport Beach is located near the southern edge of SR-55. It is an acute care, not-for-profit hospital that offers a comprehensive mix of health care services including Centers of Excellence in cancer, heart and vascular, neurosciences and women's health. It has 498 beds and employs over 1,200 physicians and 4,000 employees. Hoag Hospital Irvine, located off Sand Canyon Avenue and Alton Parkway, just off the I-405 freeway, east of SR-55. It provides a wide range of inpatient and outpatient services including a fully staffed

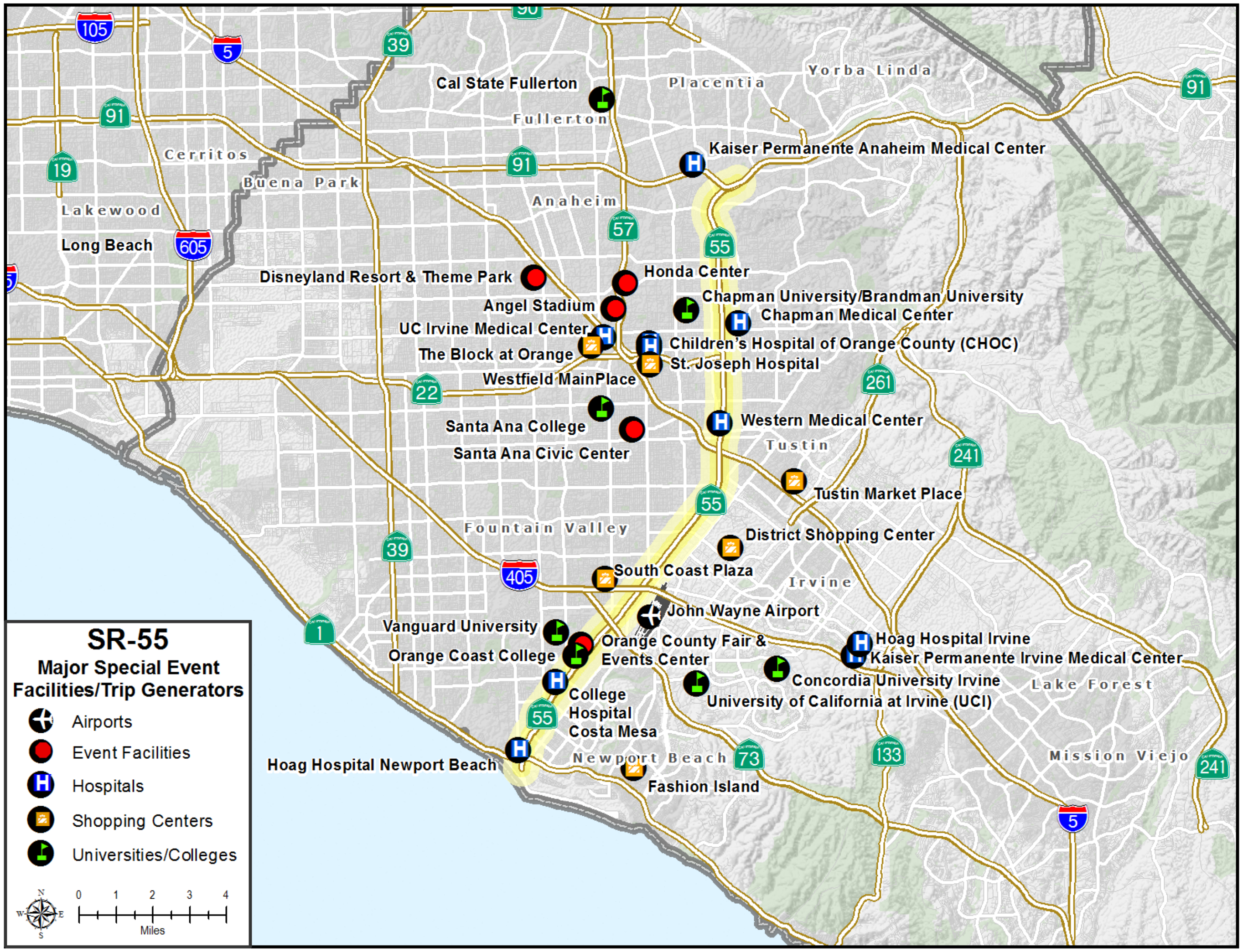
emergency room. It joins Hoag Hospital Newport Beach as a designated Cardiovascular Receiving Center.

- The UC Irvine Medical Center is the only university hospital in the county. It is located northwest of SR-55 and immediately west of the I-5/SR-22/SR-57 interchange in the City of Orange. The facility has more than 400 specialty and primary care physicians and offers a full range of acute and general care services.
- St. Joseph Hospital is located west of SR-55 and northeast of the I-5/SR-22/SR-57 interchange on Main Street. It is one of the highest volume hospitals in the county with a 1,000-member medical staff.
- The Children's Hospital of Orange County (CHOC) is adjacent to St. Joseph Hospital and is the first hospital in the county to open an emergency room for children.

The SR-55 corridor also serves many shopping facilities in the Orange County area:

- Westfield Main Place is located at the southeast corner of the I-5/SR-22 interchange west of SR-55. It is located in the city of Santa Ana and features over 200 specialty shops.
- South Coast Plaza is located just northwest of the SR-55/I-405 interchange in the city of Costa Mesa. It is an international travel destination offering 250 boutiques, 30 restaurants and four performing arts venues.
- The Block at Orange is located at the northwest of the I-5/SR-22 interchange about 3.5 miles west of SR-55. It is an outdoor shopping mall popular for its skateboarding facility and thriving nightlife.
- Tustin Marketplace is located about two miles east of SR-55. It is an outdoor retail center with more than 120 stores, services, restaurants, cafes and theaters.
- Fashion Island is located approximately three miles east of SR-55, north of SR-1. It is an outdoor shopping center with more than 200 specialty stores, 40 fine restaurants, and two movie theaters.
- The District at Tustin Legacy is located east of SR-55 between the I-5 and I-405 freeways at Dyer and Jamboree. The District is an open outdoor retail center with an AMC theater, a 30 lane bowling facility, and a Costco. It also has 25 restaurants and bars and over 30 retail shops.

Exhibit 2-12: Trip Generators on SR-55



Source: SMG/GIS/Internet

Recent Roadway Improvements

The following roadway improvements were recently completed along the SR-55 corridor.

- The SR-55 HOV facilities from Paularino Avenue to 0.2 mile north of 17th Street were recently converted to continuous access HOV in May 2011. In January 2009, a larger Caltrans maintenance project was completed that converted the remaining northern portion from 17th Street to SR-91 to continuous access HOV.

- The southbound auxiliary lane project was added from Dyer Road to MacArthur Boulevard in May 2011.

- The northbound on and off ramps between Edinger Avenue and Valencia Avenue were modified to connect to the Newport Avenue extension.

- The southbound auxiliary lane project from Edinger Avenue to Dyer Road was completed in December 2012.

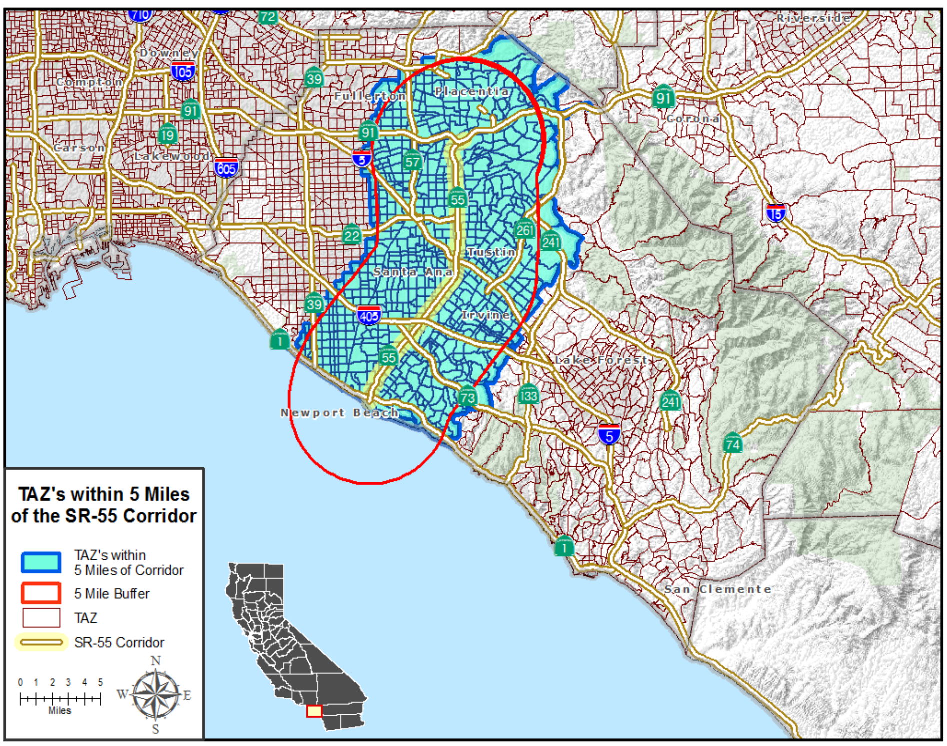
- SR-55 (Newport Boulevard) was widened in January 2011 with one lane northbound from 17th to 19th Street and one lane southbound from 19th Street to Broadway.

Corridor Socio-Economic Characteristics

This section is new for Orange County CSMPs. It has been added in part to address the increased emphasis on employment-housing balance goals of Senate Bill 375 to reduce green-house gas emissions and limit VMT growth. It also looks at socio-economic factors, namely age and income levels. This type of analysis has generally been conducted at the regional or sub-regional level. However, for this CSMP, it was decided to include corridor-specific analyses as a means to more comprehensively describe the corridor and understand the transportation demand factors.

The analysis is based on the Southern California Association of Governments (SCAG) Traffic Analysis Zone (TAZ) data. The first step of the analysis was to identify all TAZs within five miles of the SR-55 corridor. This is shown in Exhibit 2-13. The red line represents the five mile "buffer" and the blue line delineates the TAZs that fall within that distance.

Exhibit 2-13: TAZ's within 5 Miles of the SR-55 Corridor



Source: SCAG TAZ data

Exhibit 2-14 presents the summary statistics aggregated for all the TAZs within the five miles. The statistics are shown for 2008, 2020, and 2035. A few observations to note:

- The population age groups overlap. For instance, the age group from 18 to 24 is part of the age group from 16 to 64. The groupings were defined by SCAG and could not be modified.

- The number of people by age group change very little except for the over 65 age group which almost doubles from 2008 to 2035. This reflects the aging of the baby boom generation and lower employment growth (discussed later). The overall population around the corridor is projected to increase by a total 16 percent between 2008 and 2035.

- Household income is projected to decline by 0.7 percent in constant dollars (i.e., net of inflation) between 2008 and 2035. This is partly due to the aforementioned increase in population in the retirement age group. The household income increases by roughly the same percentage across each income group with over $100,000 having a slightly higher rate of 18 percent versus 17 percent.

- Overall employment grows by a little more than eight percent, which is slower than the 17 percent growth projections for both population and households. Manufacturing employment is projected to decrease by more than 17 percent. Sectors projected to increase the most in employment are construction and professional services.

- The Employment to Population Ratio declines from 2008 to 2020 and then grows from 2020 to 2035.

- The Employment to Household Ratio also declines from 2008 to 2020 and then grows from 2020 to 2035.

Exhibit 2-14: Summary Table (2008, 2020, 2035)

	2008	2020	2035	Percent Change from 2008 to 2035
Population				
Age 5 to 17	264,127	272,251	285,352	8%
Age 18 to 24	162,449	169,280	176,033	8%
Age 16 to 64	979,277	1,048,255	1,049,524	7%
Age 65 and over	132,402	188,840	262,187	98%
Total Population	**1,432,345**	**1,575,319**	**1,667,671**	16%
HouseHolds				
Median Household Income ($1999)	$ 64,136.20	$ 63,189.93	$ 63,663.24	-1%
Number of household with Less than $25,000	98,845	106,698	115,630	17%
Number of household with $25,000 to $49,999	119,870	128,779	139,904	17%
Number of household with $50,000 to $99,999	146,701	157,602	172,334	17%
Number of household with more than $100,000	91,981	99,106	108,384	18%
Total HouseHolds (Occupied Housing Units)	**457,397**	**492,185**	**536,252**	17%
Employment				
Agriculture & Mining jobs	3,105	3,314	3,351	8%
Construction jobs	62,662	68,734	84,208	34%
Manufacture jobs	95,797	82,110	79,303	-17%
Wholesale Trade jobs	46,217	43,717	47,675	3%
Retail Trade jobs	85,726	81,271	90,146	5%
Transportation and Warehousing and Utility jobs	24,758	23,141	26,373	7%
Information jobs	19,396	18,694	19,009	-2%
Financial Activity(FIRE) jobs	75,111	73,970	76,089	1%
Professional and Business Services jobs	200,267	216,347	239,920	20%
Education and Health Services jobs	169,264	175,813	182,199	8%
Leisure and Hospitality (art/entertainment) jobs	107,792	103,177	120,037	11%
Other services jobs	32,109	32,204	32,851	2%
Public/administration jobs	23,905	22,664	23,840	0%
Total Employment	**946,109**	**945,156**	**1,025,001**	8%
Employment Population Ratio				
Ratio (Total Employment/Total Population)	**0.66**	**0.60**	**0.61**	-7%
Employment Housing Ratio				
Ratio (Total Employment/Total Households)	**2.07**	**1.92**	**1.91**	-8%

Source: SCAG TAZ data

The rest of this section presents maps that show some of the statistics by TAZ instead to complement the aggregate statistics just discussed. Three maps for 2008 are presented for the selected TAZs:

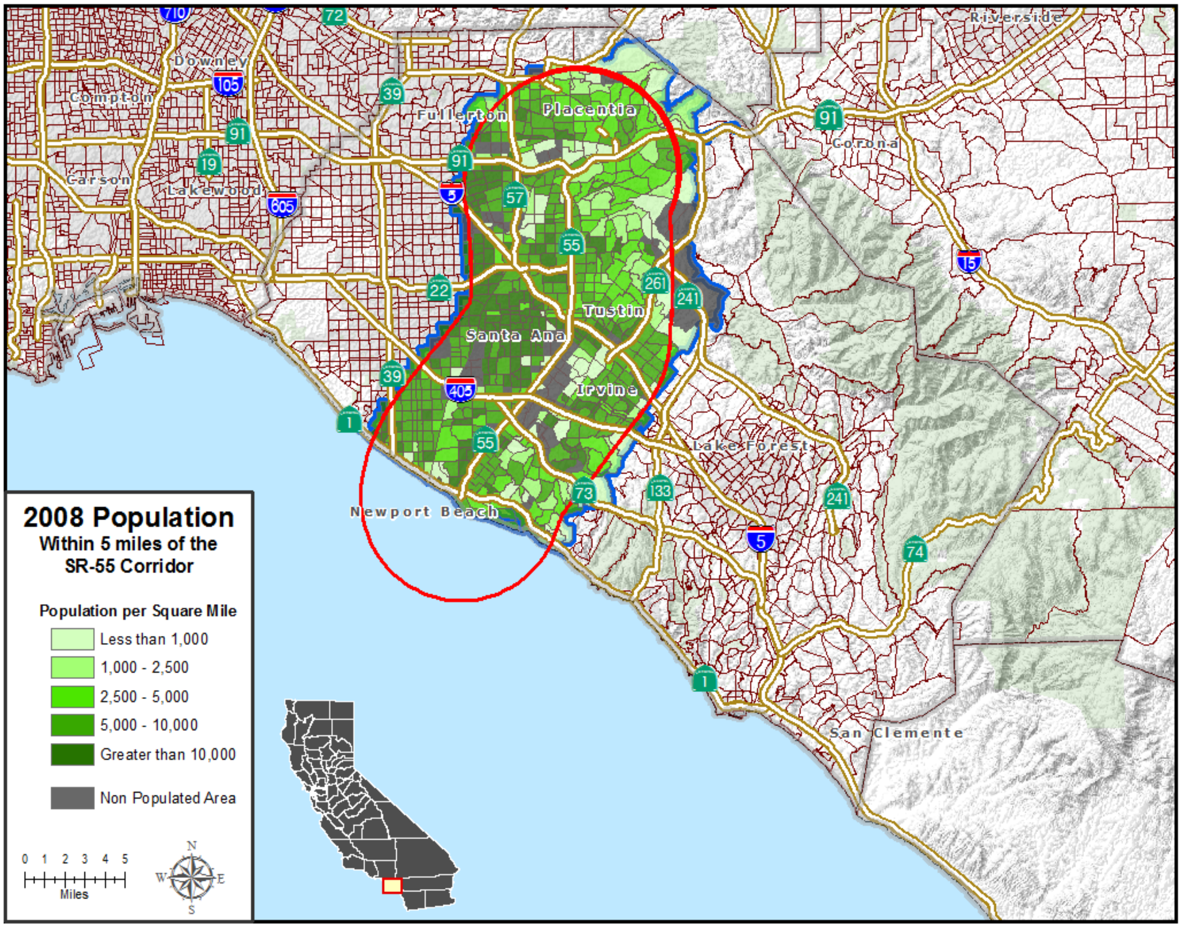
- Population Density – defined as population per square mile
- Employment Density – defined as employment per square mile
- Employment/Population Ratio – defined as the TAZ employment divided by TAZ population.

The Population Density presented in Exhibit 2-15, shows that the density around the SR-55 in the Orange/Santa Ana area is greatest, generally higher than 10,000 people per square miles. Further north along the SR-55 corridor near SR-261, south of SR-91, and south of SR-73, the density is much less.

The Employment Density, presented in Exhibit 2-16, also shows that the Orange/Santa Ana has some of the highest employment concentrations in a triangle formed by SR-55, SR-91, and I-5. High employment concentrations can also be seen in Irvine and Placentia.

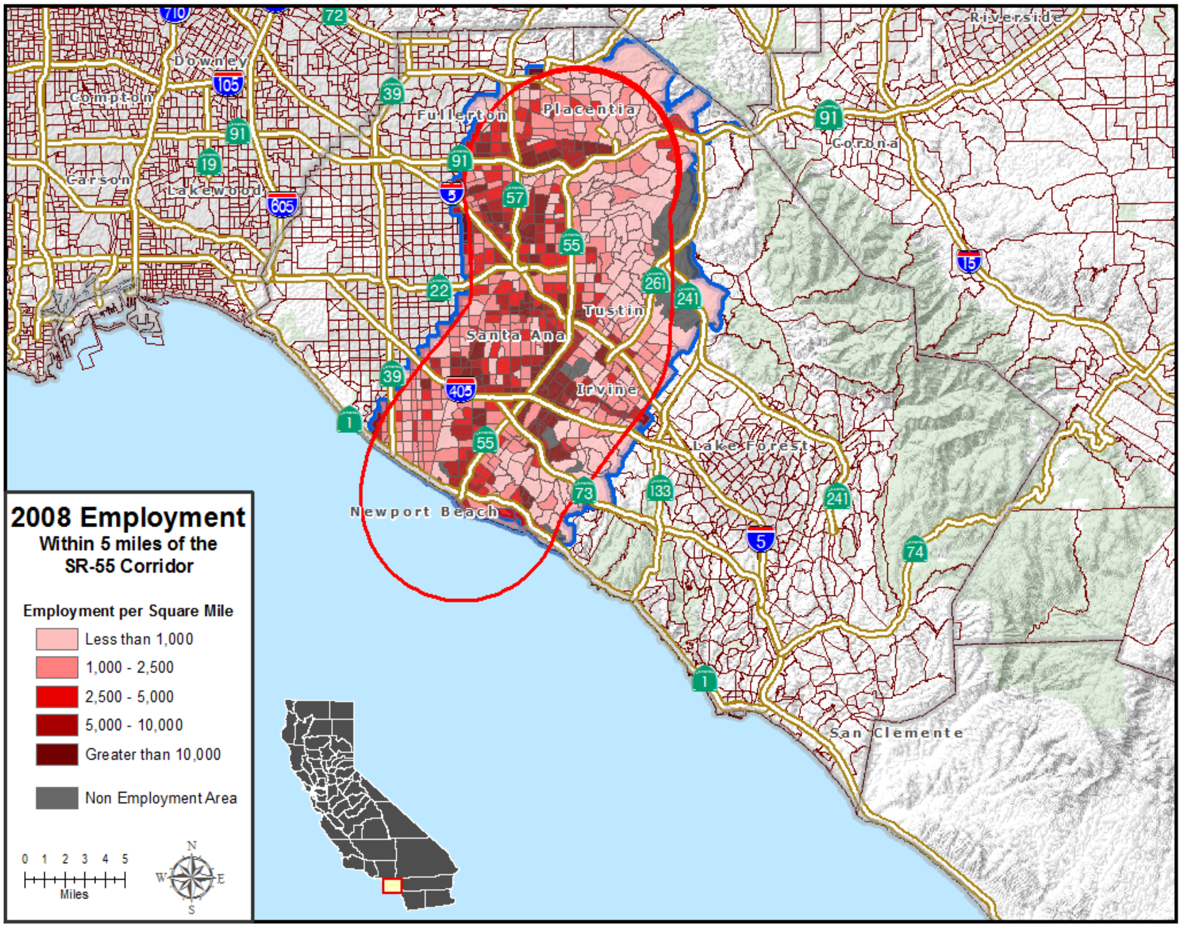
In Exhibit 2-17, the Employment Ratio is mapped out by dividing the TAZ employment total by the TAZ population total.

Exhibit 2-15: 2008 Population within 5 miles of the SR-55 Corridor



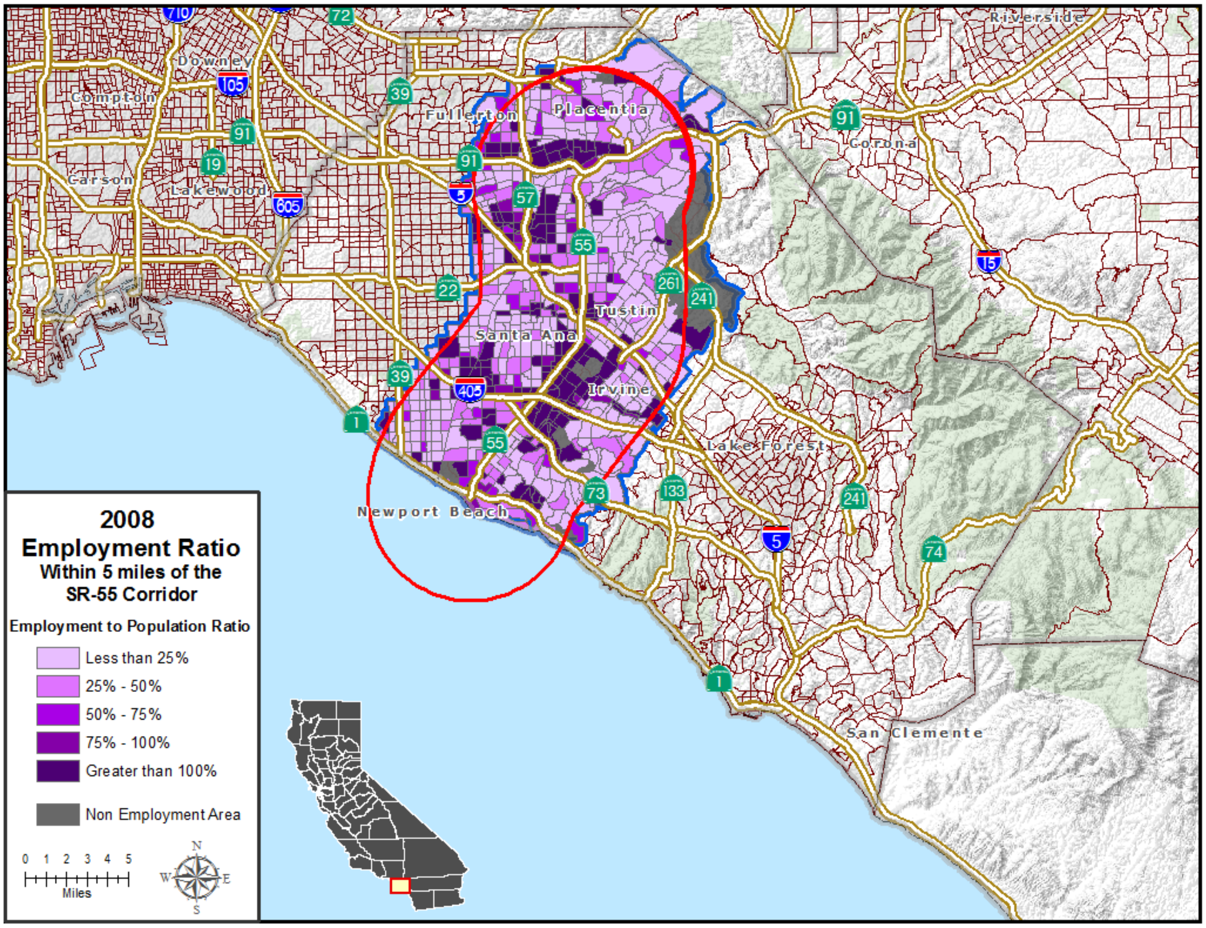
Source: SCAG TAZ data

Exhibit 2-16: 2008 Employment within 5 miles of the SR-55 Corridor



Source: SCAG TAZ data

Exhibit 2-17: 2008 Employment Ratio within 5 miles of the SR-55 Corridor



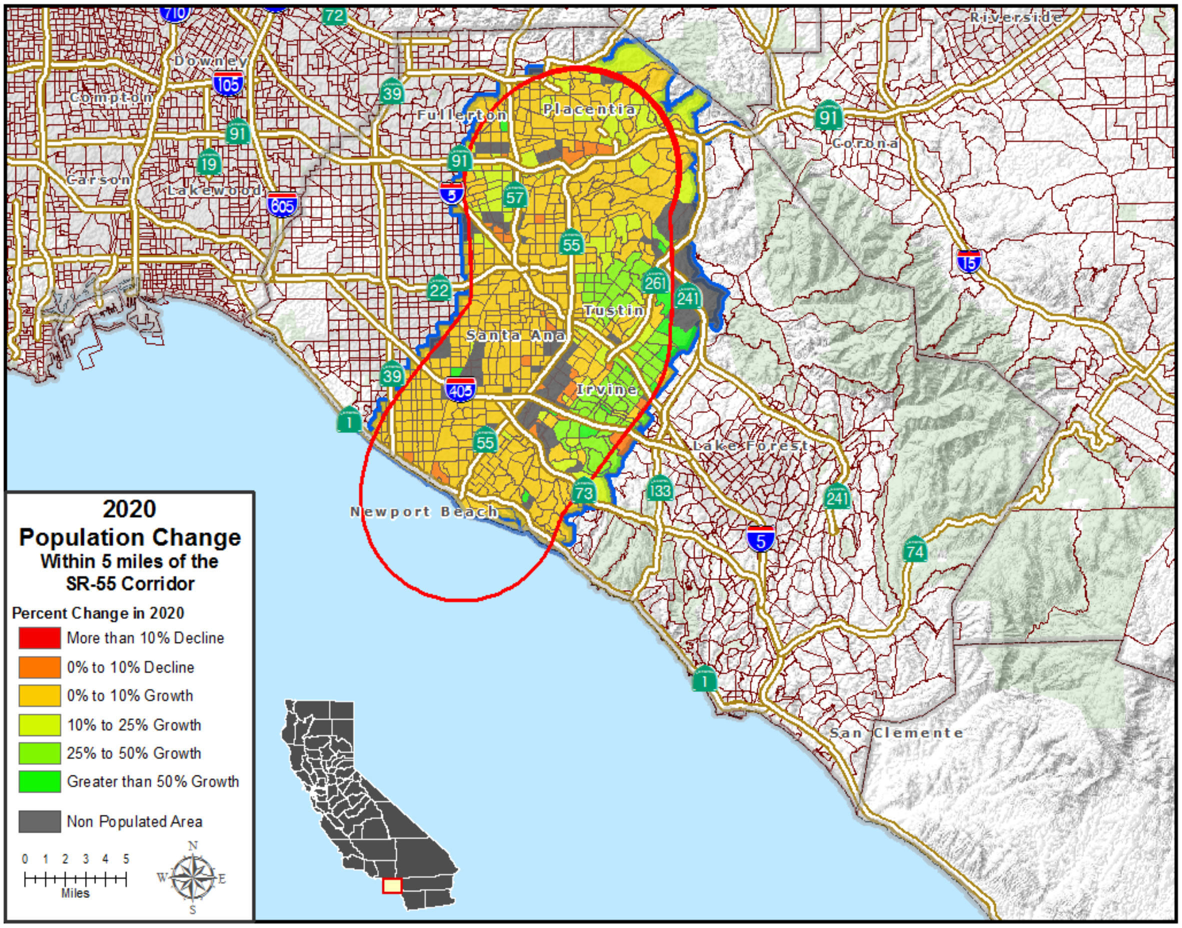
Source: SCAG TAZ data

Exhibit 2-18 shows the Population Change from 2008 to 2020. The map shows most of the TAZs within the 5 miles radius of the SR-55 is projected to grow by less than 10 percent (the 0-10% category on the map). A few TAZs are projected to actually experience modest declines in population. The area of Irvine and Tustin is projected to grow by more than 25%.

Exhibit 2-19 presents the projected Employment Change from 2008 to 2020. A few areas are projected to experience 25% or greater employment growth, including: Tustin and North Placentia. Notably, the Santa Ana and Placentia areas are projected to see a net decline in jobs. The area south of SR-73 near San Joaquin Hills has more than a 10 decline.

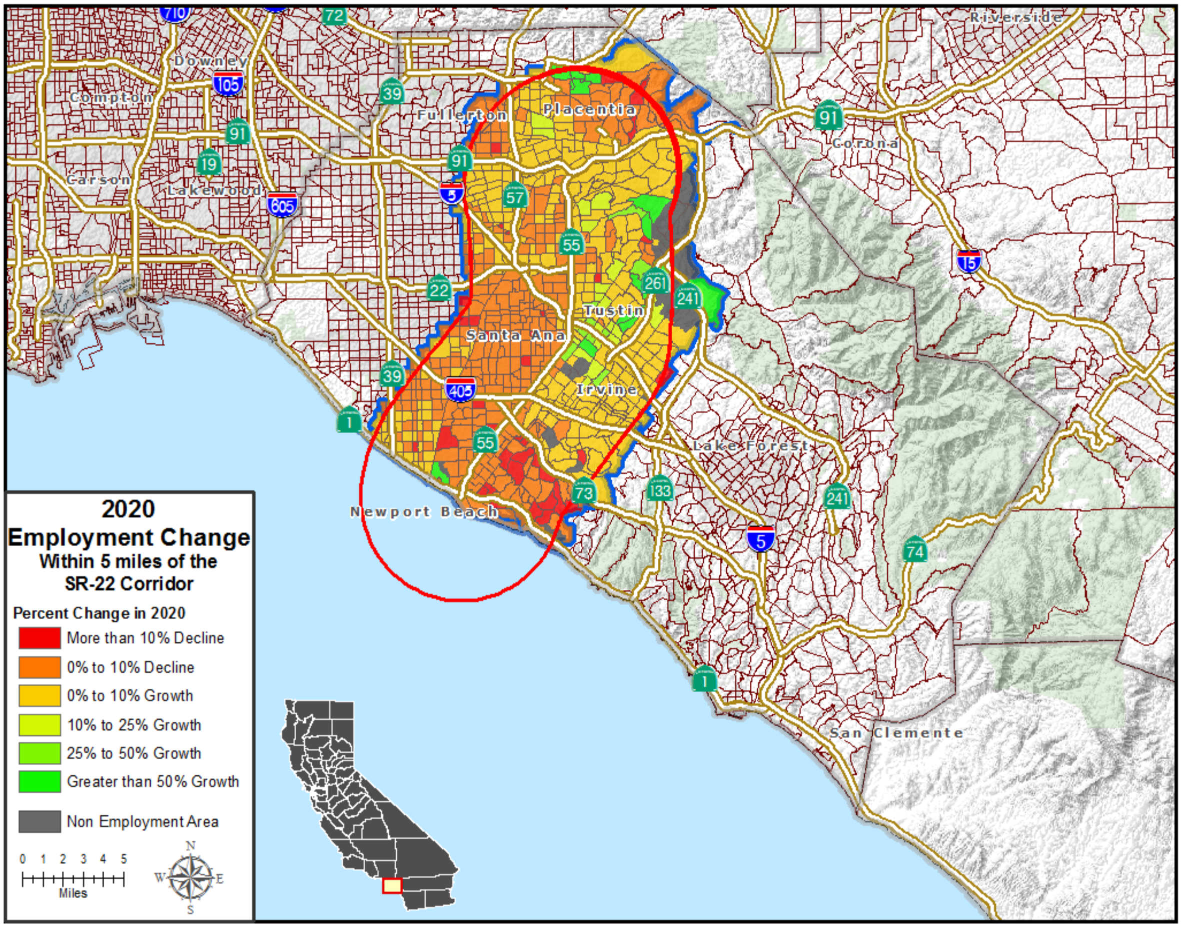
Exhibit 2-20 presents the Employment Ratio for the year 2020. The areas with the highest projected ratios are parts of Irvine, Orange, Placentia and Fullerton.

Exhibit 2-18: 2020 Population Change within 5 miles of the SR-55 Corridor



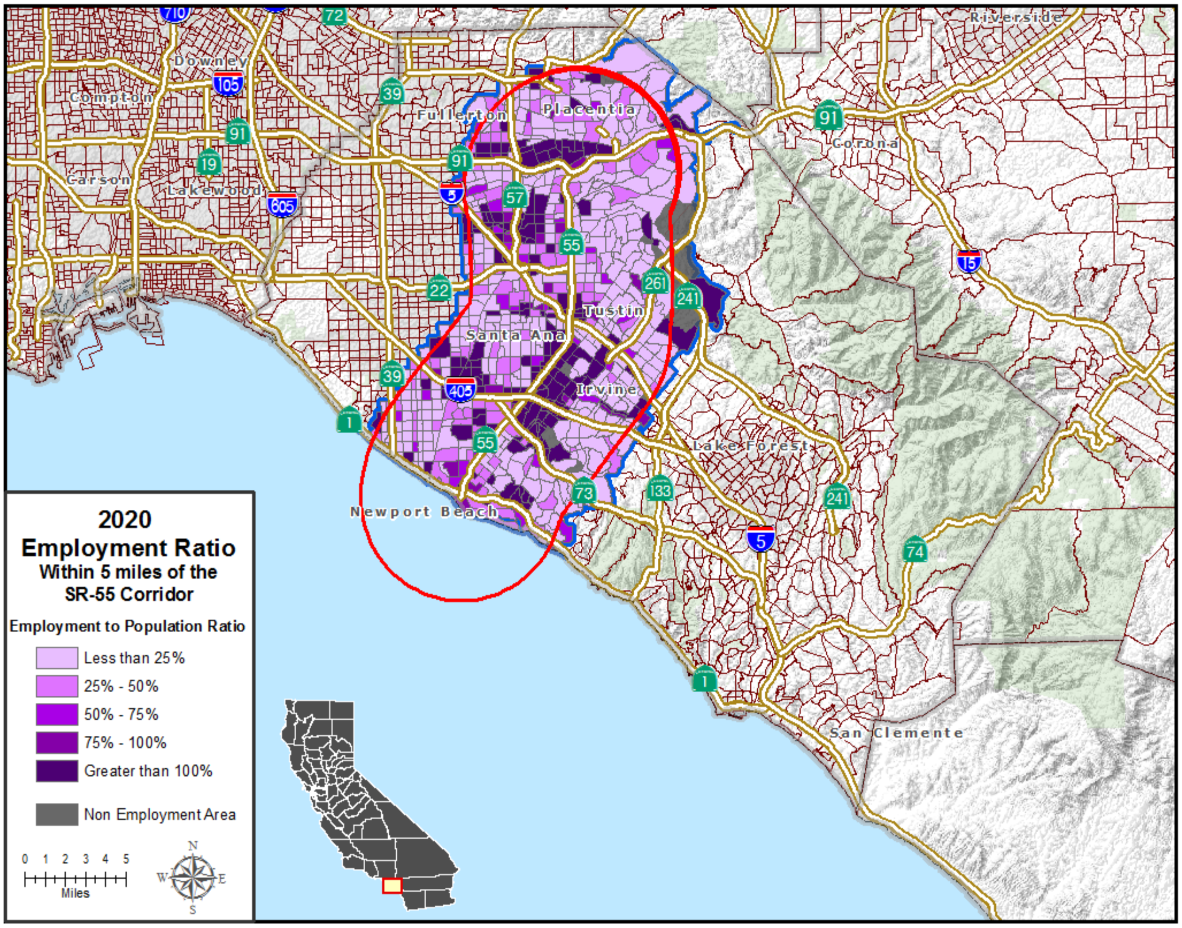
Source: SCAG TAZ data

Exhibit 2-19: 2020 Employment Change within 5 miles of the SR-55 Corridor



Source: SCAG TAZ data

Exhibit 2-20: 2020 Employment Ratio within 5 miles of the SR-55 Corridor



Source: SCAG TAZ data

3. CORRIDOR-WIDE PERFORMANCE AND TRENDS

This section summarizes the performance measures used to evaluate the existing conditions of the SR-55 corridor. The measures provide a technical basis to describe traffic performance on SR-55. Data from the mainline and high occupancy vehicle (HOV) facilities are only available on the freeway portion of SR-55. Therefore, the performance measures provide mainline and HOV analyses on SR-55 from north of 19th Street to SR-91 only and do not include the arterial section from Finley Avenue to 19th Street.

Before discussing the performance measures, this section describes the quality of the data used in the analysis. This was done to ensure that the automatic detector data used for the analysis was sufficiently reliable.

Following the data quality discussion, the following five key performance areas will be discussed in detail:

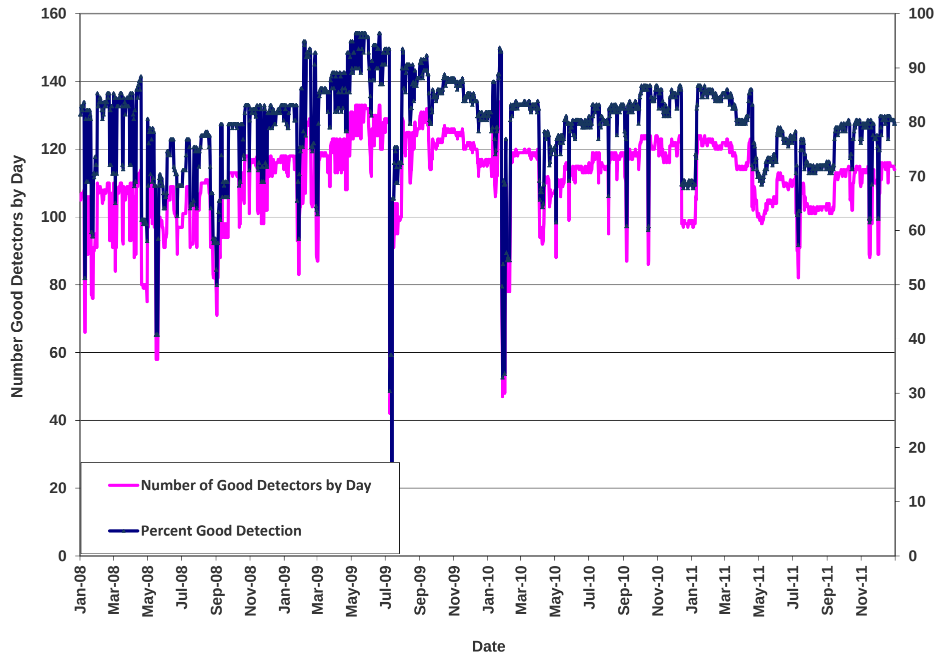
- *Mobility* describes how quickly people and freight move along the corridor.
- *Reliability* captures the relative predictability of travel time along the corridor.
- *Safety* provides an overview of collisions along the corridor.
- *Productivity* quantifies the degree to which traffic inefficiencies at bottlenecks or hot spots reduce flow rates along the corridor.
- *Pavement Condition* describes the structural adequacy and ride quality of the pavement.

Detection

Given the need for comprehensive and continuous monitoring and evaluation, detection coverage and quality are discussed in greater detail.

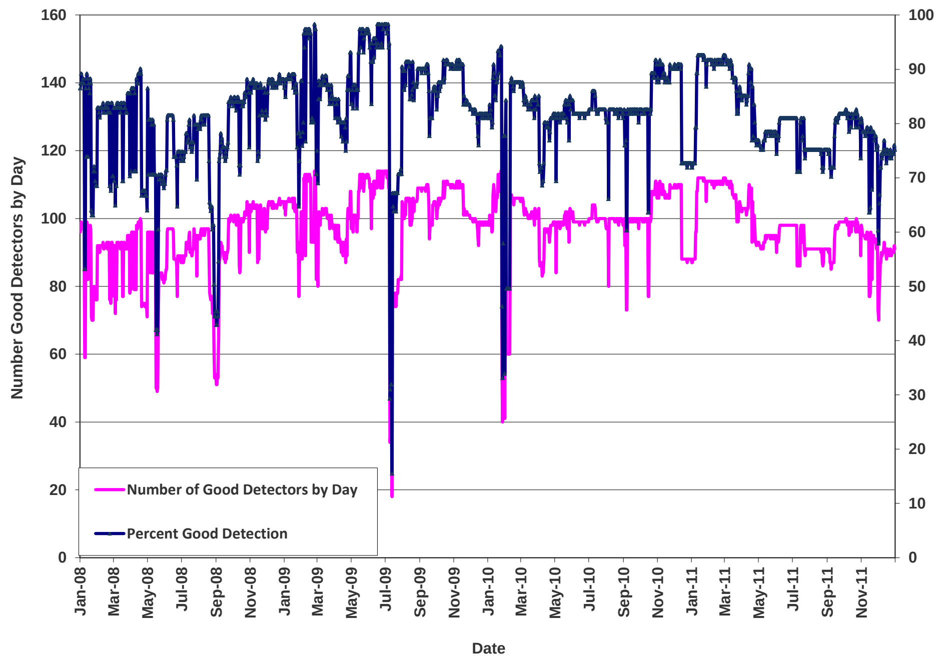
Exhibits 3-1 and 3-2 report the number and percentage of “good” detectors by day for the mainline facility of SR-55 from 2008 to 2011. The left y-axis shows the scale used for the number of detectors, while the right y-axis shows the scale used for the percent good detectors. These exhibits suggest that detection in both directions of the mainline was about the same, hovering between 80 and 90 percent good detection on average. Detection quality dropped dramatically for a few days in both directions in July 2009 and January 2010. In addition, detection quality dropped slightly from the first quarter of 2011 to the latter part of the year.

Exhibit 3-1: Amount of Good Detection on Northbound SR-55 Mainline (2008-2011)



Source: Caltrans detector data

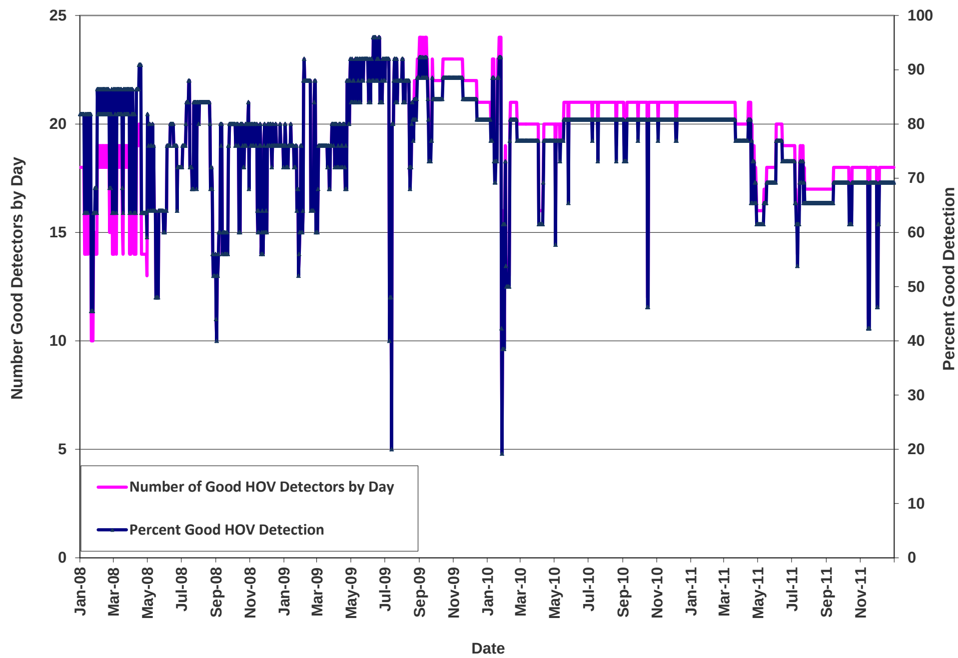
Exhibit 3-2: Amount of Good Detection on Southbound SR-55 Mainline (2008-2011)



Source: Caltrans detector data

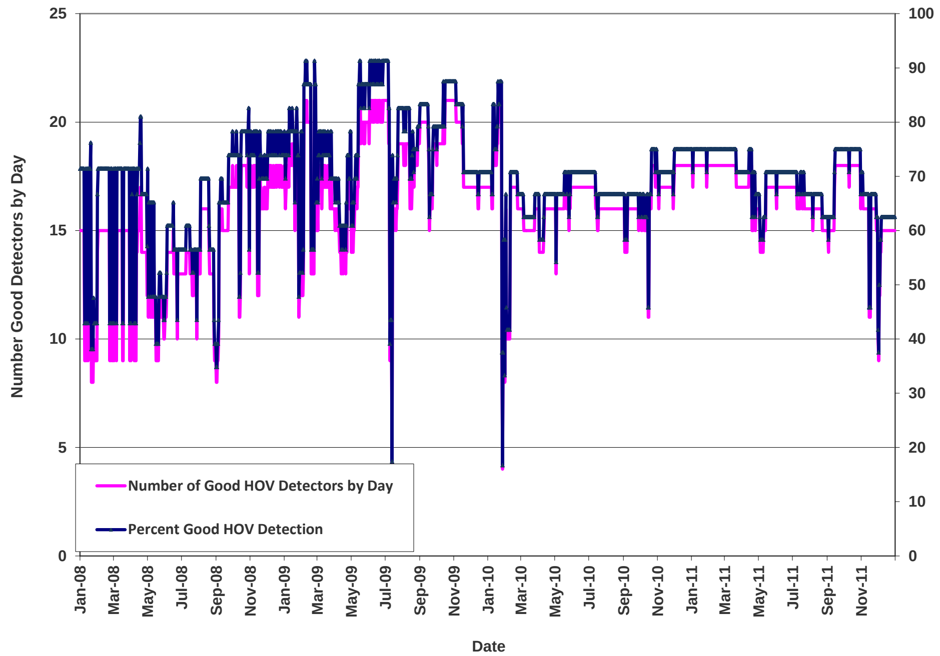
Exhibits 3-3 and 3-4 reports the number and percentage of good detectors on the HOV facility. Both directions of the HOV lane exhibited between 70 and 90 percent good detection. The northbound HOV lane reported slightly better detection than the southbound HOV lane. Similar to the mainline facility, detection on the HOV lane remained steady with some dramatic drops for a few days in mid-2009 and early-2010 with some drops in 2011.

Exhibit 3-3: Amount of Good Detection on Northbound SR-55 HOV Lane (2008-2011)



Source: Caltrans detector data

Exhibit 3-4: Amount of Good Detection on Southbound SR-55 HOV Lane (2008-2011)



Source: Caltrans detector data

An analysis of gaps without detection (greater than 0.75 miles in length) is shown in Exhibit 3-5 for the mainline facility and Exhibit 3-6 for the HOV facility. The locations with the "1" or "2" suffix represent the first set or second set of detectors that are installed at that interchange, usually within 1,000 feet of each other. There are several segments extending over 0.75 miles without detection in each direction for both directions in the mainline facility and for the only the southbound direction in the HOV facility. A mainline detector station is available at the northbound Victoria2 location, however, this station is not currently connected to PeMS or to the Advanced Transportation Management System (ATMS) in the Caltrans Traffic Management Center. These detection segment gaps should be considered for deployment of additional detection when funding becomes available.

Exhibit 3-5: SR-55 Mainline Gaps In Detection (November 30, 2011)

From		To		Length (Miles)
Location	Abs PM	Location	Abs PM	
Northbound Mainline				
Finley	0.00	Victoria 1	2.77	2.77
Victoria 1	2.77	Fair 1	3.59	0.82
Meats	16.18	Lincoln2	17.10	0.92
Lincoln2	17.10	SR-91	17.876	0.78
Southbound Mainline				
Junction 91	17.876	Lincoln 1	16.692	1.184
17th 1	11.602	Fourth 1	10.822	0.78
Victoria 1	2.77	Finley	0.00	2.77

Source: Caltrans detector data

Exhibit 3-6: SR-55 HOV Gaps In Detection (November 30, 2011)

From		To		Length (Miles)
Location	Abs PM	Location	Abs PM	
Northbound HOV (None)				
Southbound HOV				
Lincoln 1	16.692	Taft	15.782	0.91
17th 1	11.602	Fourth 1	10.822	0.78
McFadden	10.00	Edinger 1	9.19	0.81

Source: Caltrans detector data

Mobility

Mobility describes how well the corridor moves people and freight. The mobility performance measures are both readily measurable and straightforward for documenting current conditions and are readily forecasted making them useful for future comparisons. Two primary measures are typically used to quantify mobility: delay and travel time.

DELAY

Delay is defined as the total observed travel time less the travel time under non-congested conditions, and is reported as vehicle-hours of delay. Delay can be computed for severe congested conditions using the following formula:

$$(Vehicles\ Affected\ \ per\ Hour) \times (Dis\tan ce) \times (Duration) \times \left[\frac{1}{(Congested\ Speed)} - \frac{1}{35mph} \right]$$

In the formula above, the *Vehicles Affected per Hour* value depends on the methodology used. Some methods assume a fixed flow rate (e.g., 2,000 vehicles per hour per lane), while others use a measured or estimated flow rate. The distance is the length under which the congested speed prevails and the duration is the hours of congestion experienced below the threshold speed.

The threshold speed can also vary. In general, the threshold speed represents free-flow or some other pre-defined speed. In this CSMP analysis, 60 mph is considered free-flow speed for the corridor, and will be used to calculate delay. Different reports and studies use other threshold speeds, typically 35 mph (e.g. HICOMP), which is defined here as the “severe congestion” speed threshold, and 45 mph (Federal Highway Administration threshold to define HOV degradation).

Caltrans MPR

The Mobility Performance Report 2009 (MPR 2009) is a new report prepared by Caltrans that provides transportation system performance information at a statewide level for each Caltrans district. It replaces the HICOMP Report previously prepared by Caltrans up to 2008. The MPR 2009 presents annual vehicle hours of delay (AVHD), lost productivity, and bottleneck locations. It uses a new, standardized statewide methodology for measuring freeway traffic congestion from detector data collected from Caltrans PeMS. Delay is determined by calculating the difference between the observed travel time and the travel time at two benchmark speeds, 35 mph and 60 mph. The hours of delay are then multiplied by the vehicular flow on the facility to produce

VHD. Within District 12 in 2009, the AVHD at 35 mph is 9,736,000 comprising over 12 percent of statewide delay, the AVHD at 60 mph is 21,792,000 comprising over 11 percent of statewide delay.

The MPR 2009 lists the District's top twenty freeway bottleneck locations in 2009 and the suspected causes of the bottlenecks. Three of the bottlenecks are on SR-55. Southbound SR-55 at Victoria 1 is listed as the No. 5 bottleneck with the suspected cause being a downstream traffic signal at 19th Street and Newport Boulevard near the end of the freeway. Northbound SR-55 at Dyer 2 is listed as the No. 8 bottleneck with the suspected cause of two lane drops at Alicia Parkway and a lane drop at El Toro. Southbound SR-55 at south of I-5 is listed as the No. 17 bottleneck with the suspected cause of the bottleneck due to a lane drop.

Caltrans Detector Data

The performance assessment includes four years of automatic detector data: 2008, 2009, 2010, and 2011. Delay presented in this section represent the difference in travel time between actual conditions and free-flow conditions at 60 miles per hour, applied to the actual output flow volume collected from a vehicle detector station.

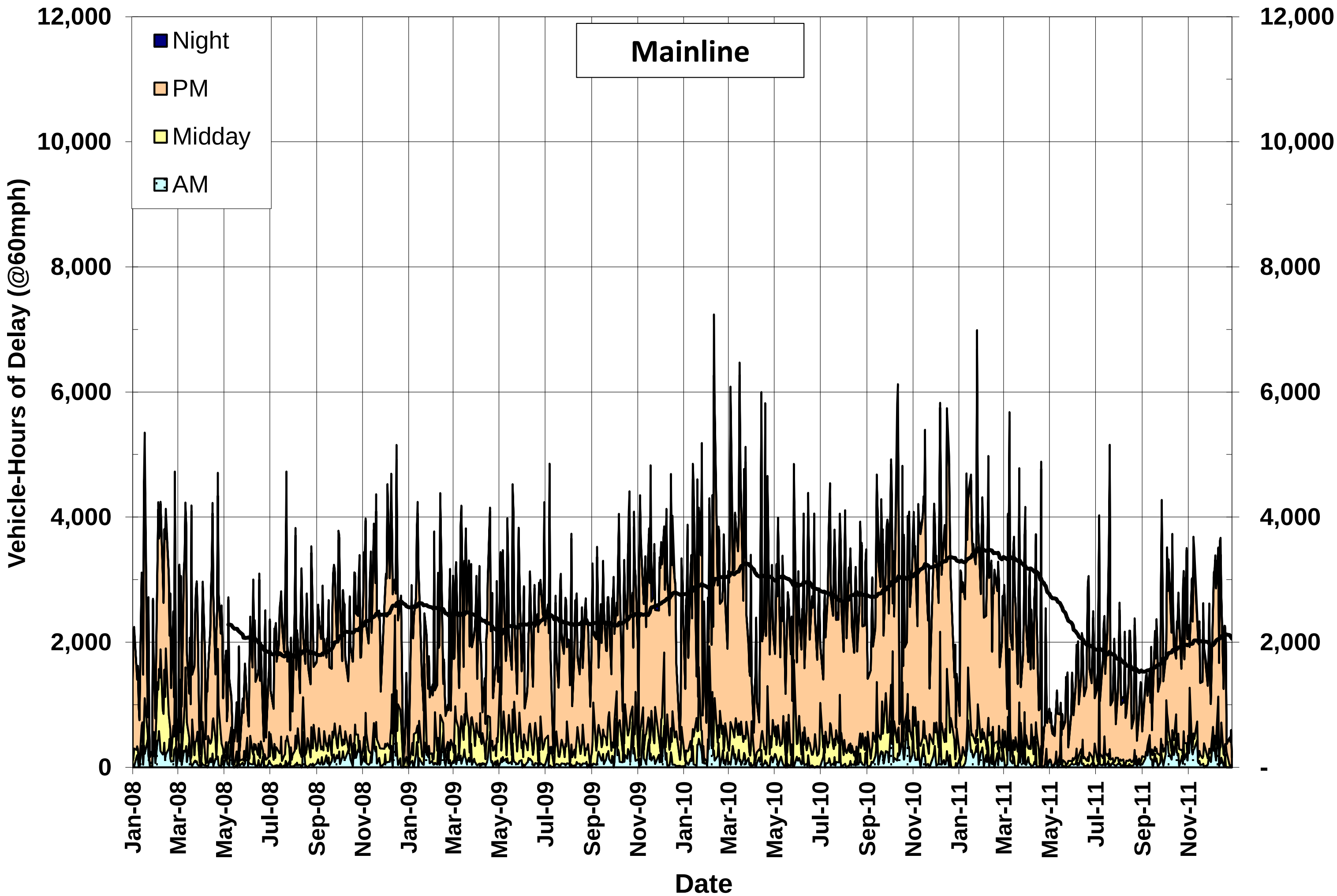
Exhibits 3-7 through 3-10 illustrate the delay experienced on weekdays (i.e., excluding weekends and holidays) for the study corridor. Exhibits 3-8 and 3-9 report delay on the mainline facility while Exhibits 3-9 and 3-10 report delay on the HOV facility. The exhibits also show a 90-day moving average (represented by the horizontal curved line) that reduces the day-to-day variations and more easily illustrates the seasonal and annual changes in congestion over time. Total delay along the study corridor was computed for four time periods: AM peak (6:00 AM to 9:00 AM), midday (9:00 AM to 3:00 PM), PM peak (3:00 PM to 7:00 PM), and evening/early AM (7:00 PM to 6:00 AM).

As indicated in Exhibits 3-7 and 3-8, daily delay on the mainline facility was greater in the southbound direction than the northbound. As shown in Exhibit 3-7, daily delay in the northbound direction of the mainline was concentrated in the PM peak period, as noted by the tan shading.

Exhibit 3-8 shows average daily delay for the southbound direction. While southbound congestion during the AM peak period occurs year round, during the summer months, midday congestion also occurs given that SR-55 serves as the major route for summer beach traffic. Delays were highest in 2010 with over 80 percent of total delays during the PM period in the northbound direction. For the southbound direction, delay in the AM peak accounted for about 41 percent. Delay for the midday accounted for about 35 percent in the southbound direction. While northbound delay increased from 2008 to 2010 and decreased in 2011, southbound delay increased slightly every year from 2008 through 2011.

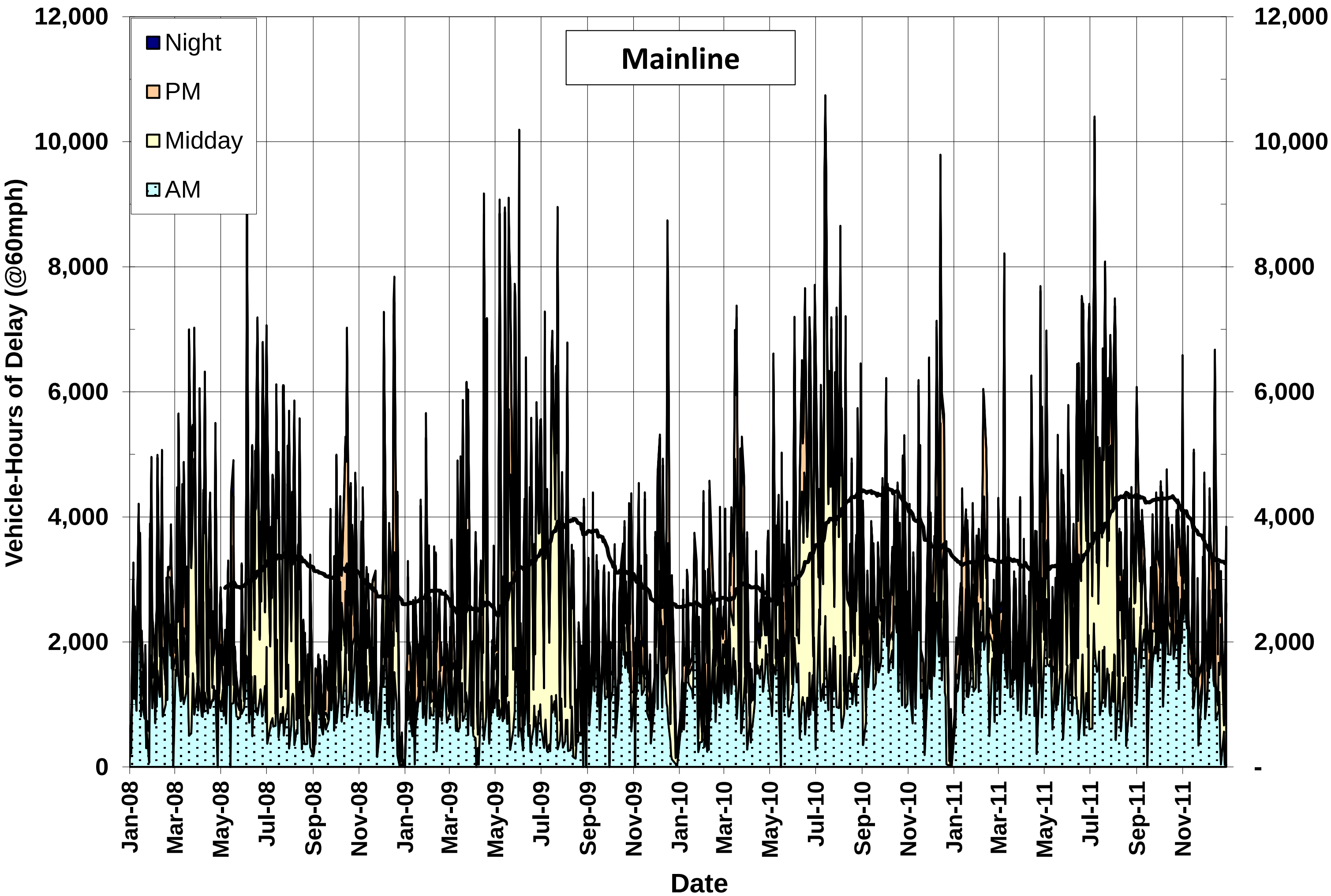
Exhibits 3-9 and 3-10 show the daily delay on the HOV facility for the same four year period. Similar to the mainline facility, delay on the HOV facility was highest in 2010. Daily delay in the northbound direction was higher than the southbound direction in 2008, however, in 2009 and 2010, delay increased in the southbound direction where it exceeded delay in the northbound direction due to increases in travel demand in the southbound direction. Both northbound and southbound delay decreased from 2010 to 2011. Similar to the mainline facility, the northbound delay was concentrated in the PM peak period while the southbound delay was concentrated in the AM peak period.

Exhibit 3-7: Northbound SR-55 ML Average Daily Delay by Time Period (2008-2011)



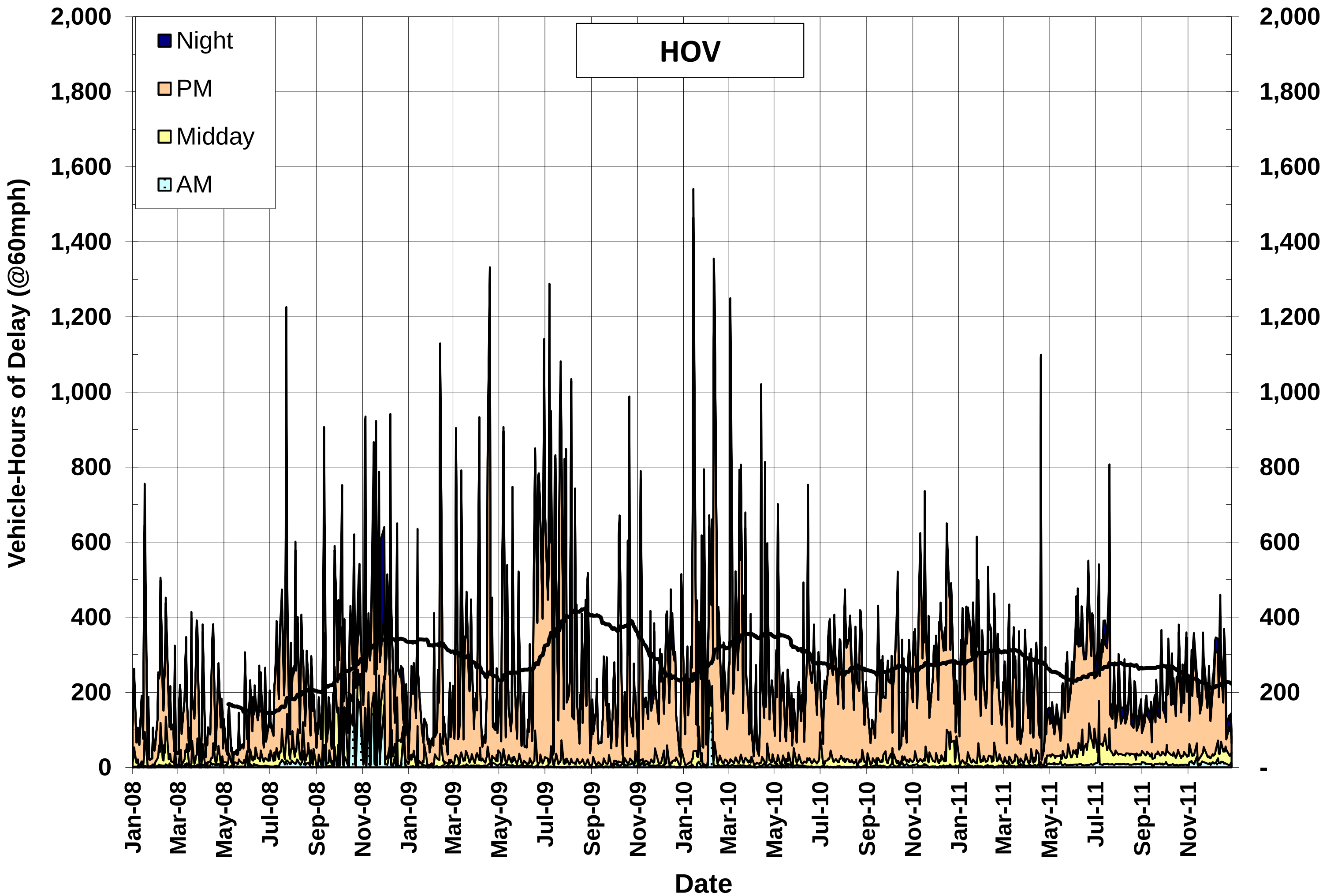
Source: Caltrans detector data

Exhibit 3-8: Southbound SR-55 ML Average Daily Delay by Time Period (2008-2011)



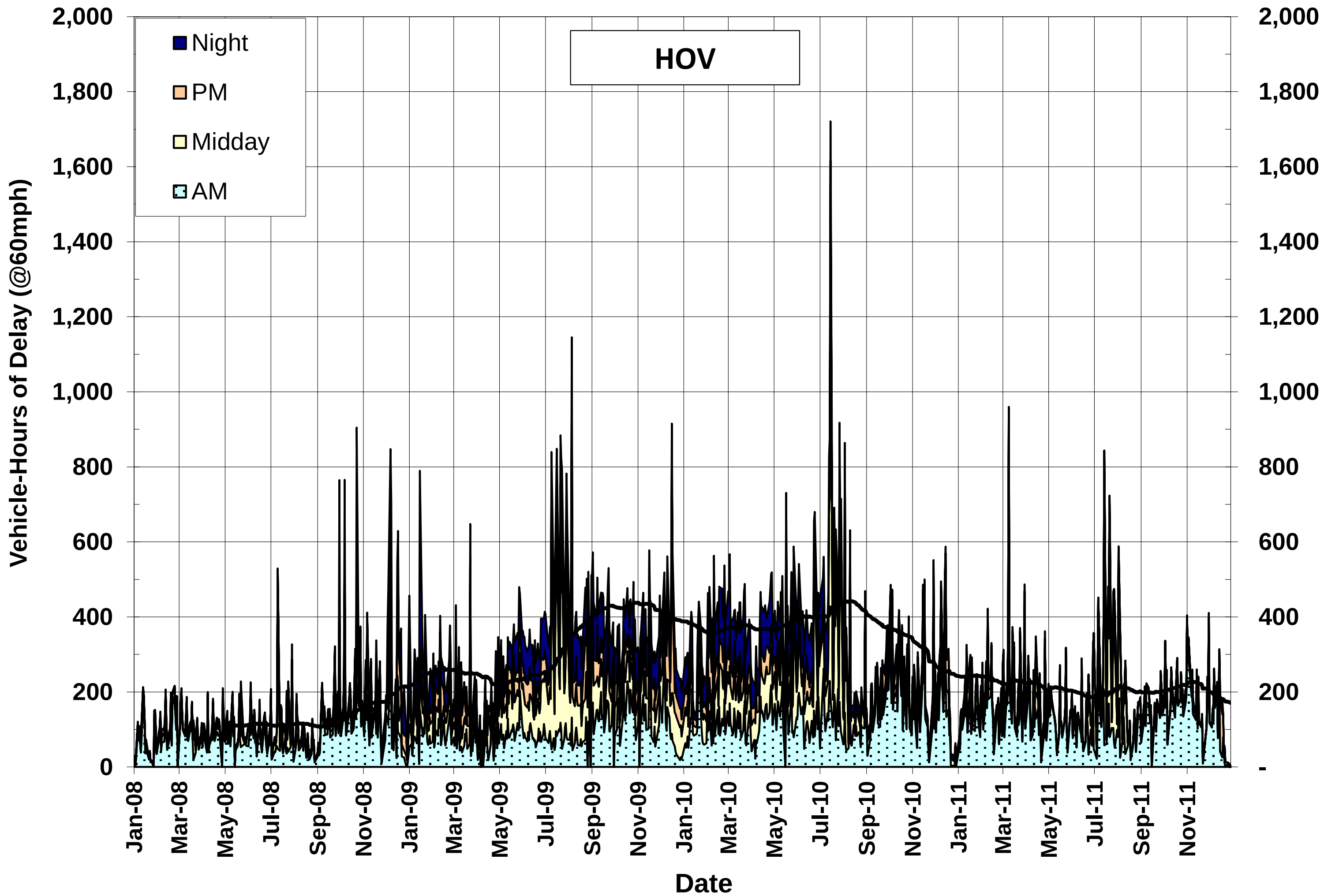
Source: Caltrans detector data

Exhibit 3-9: Northbound SR-55 HOV Average Daily Delay by Time Period (2008-2011)



Source: Caltrans detector data

Exhibit 3-10: Southbound SR-55 HOV Average Daily Delay by Time Period (2008-2011)

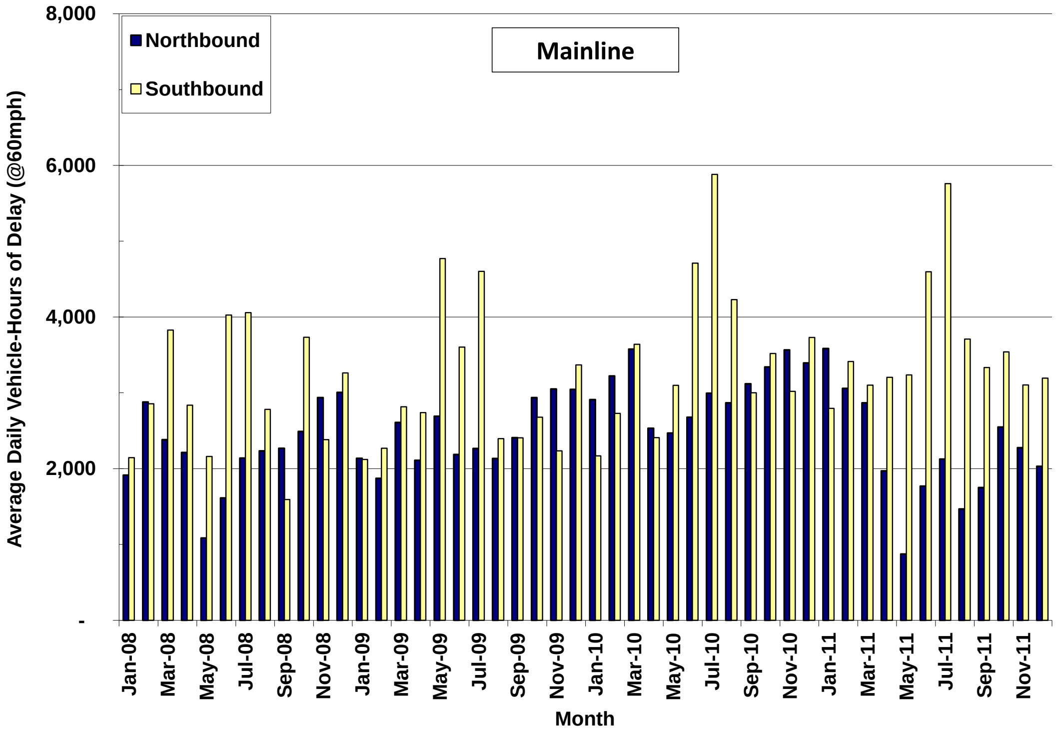


Source: Caltrans detector data

Exhibit 3-11 shows the average weekday daily vehicle-hours of delay for each month between 2008 and 2011 for the mainline facility. These figures exclude weekends and holidays. This exhibit reveals the following delay trends on the mainline:

- Congestion on the mainline increased from 2008 to 2010 and decreased in 2011.
- Southbound delay exceeded northbound delay for most months during the four-year period.
- Southbound delay increased slightly from 2008 to 2011 while northbound delay increased from 2008 to 2010 but decreased from 2010 to 2011.

Exhibit 3-11: SR-55 ML Average Weekday Delay by Month (2008-2011)

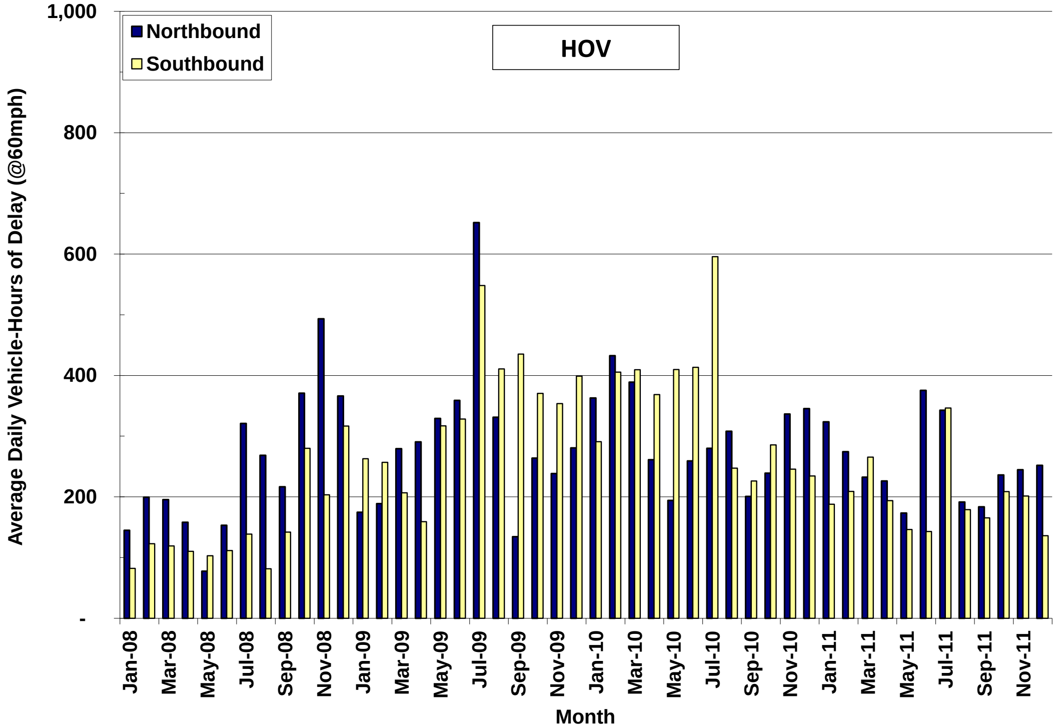


Source: Caltrans detector data

Exhibit 3-12 reveals the following delay trends for the HOV facility:

- Similar to the mainline, congestion on the HOV facility increased from 2008 to 2010 and decreased in 2011.
- Northbound delay exceeded southbound delay in 2008 but southbound delay increased in 2009 and 2010 due to increases in travel demand in the southbound direction. Both northbound and southbound delay decreased slightly in 2011.

Exhibit 3-12: SR-55 HOV Average Weekday Delay by Month (2008-2011)



Source: Caltrans detector data

The exhibits presented above reflect congestion delay from speeds falling below 60 miles per hour (free-flow) threshold speed. This delay can be segmented into two components as shown in the following two exhibits:

- Severe delay – delay occurring when speeds are below 35 miles per hour.
- Other delay – delay occurring when speeds are between 35 and 60 miles per hour.

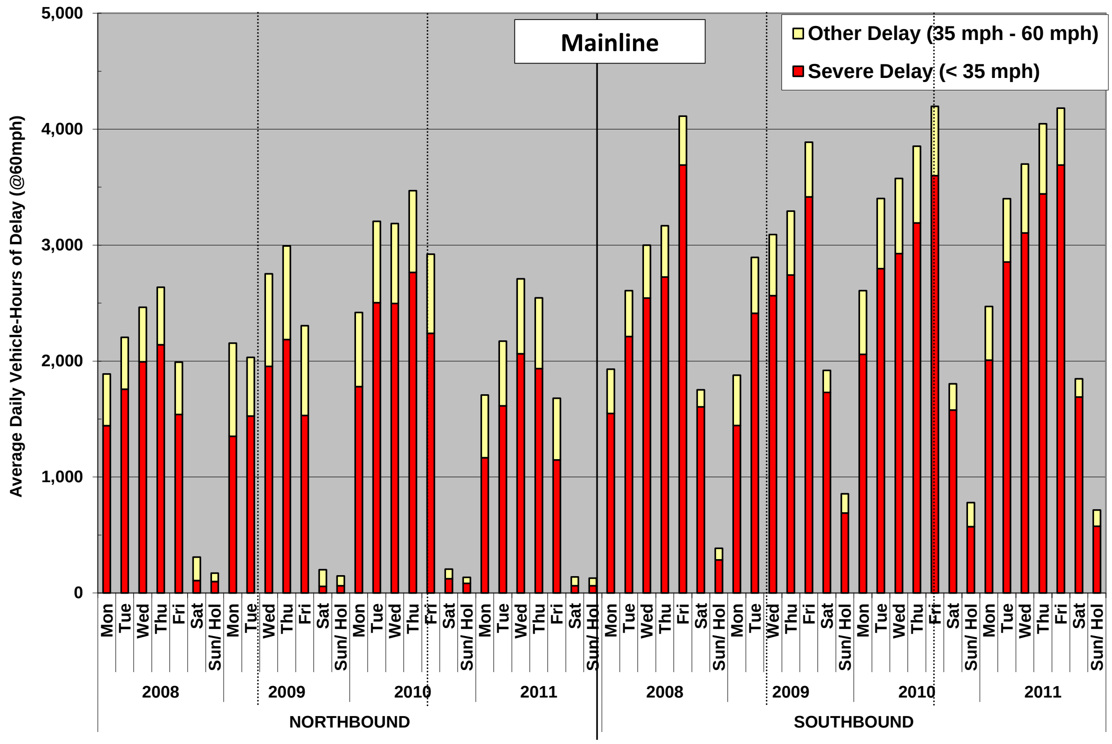
Severe delay represents breakdown conditions and is the focus of most congestion mitigation strategies. "Other" delay represents conditions approaching the breakdown congestion, leaving the breakdown conditions, or areas that cause temporary slowdowns rather than widespread breakdowns.

Exhibit 3-13 shows average severe and other daily vehicle-hours of delay by day of the week for the mainline facility. As depicted in the exhibit:

- Severe delay makes up to 81 percent of all weekday delay on the corridor in the northbound direction and up to 92 percent the southbound direction.

- Thursdays experienced the highest delays in the northbound direction while Fridays experienced the highest delays in the southbound direction. This increase in Friday traffic, as well as the higher overall southbound weekend congestion may reflect summer beach traffic.

Exhibit 3-13: SR-55 ML Average Delay by Day of Week by Severity (2008-2011)

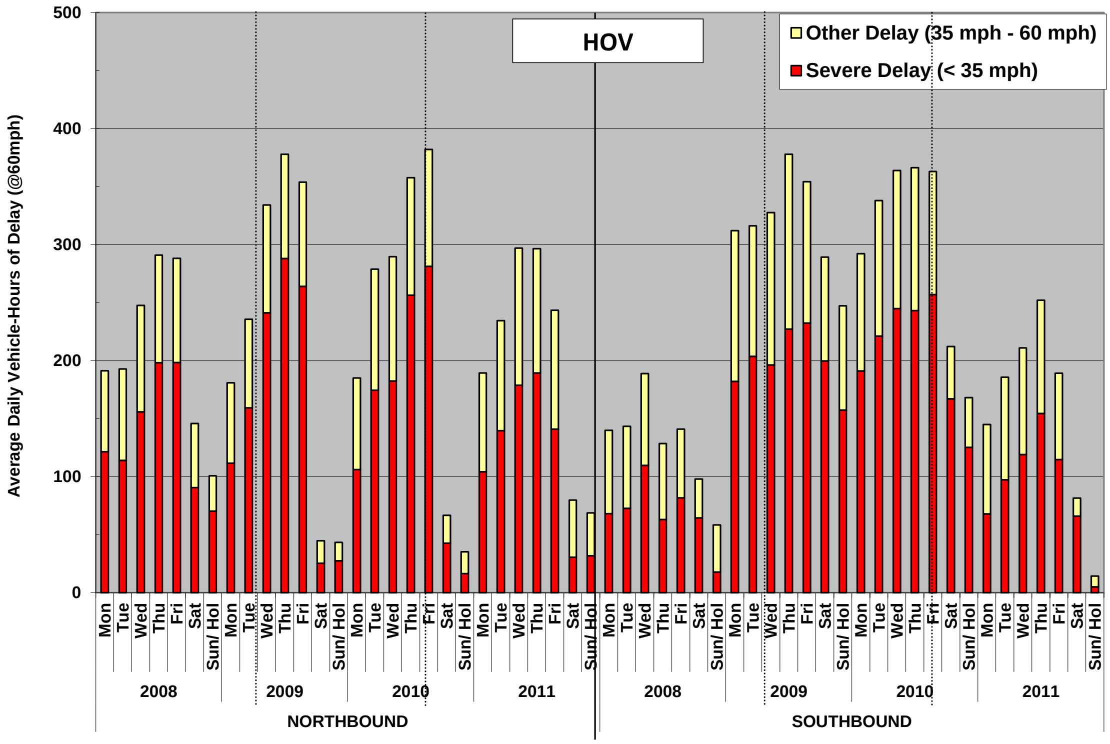


Source: Caltrans detector data

Exhibit 3-14 summarizes the delay trend for the HOV facility:

- Severe delay makes up to 76 percent of all weekday delay on the corridor in the northbound direction and up to 81 percent in the southbound direction.
- Thursdays and Fridays experienced the highest delays in the northbound direction. In the southbound direction, Fridays experienced slightly higher congestion than Thursdays, however, in 2011, Thursdays experienced higher delay than other days of the week.
- Southbound delay increased significantly from 2008 to 2009. It increased slightly from 2009 to 2010 and decreased in 2011. Northbound delay increased slightly from 2008 to 2010 and also decreased in 2011.
- Delay was highest in 2010 compared to the other three years, and greater in the southbound direction than the northbound except in 2008 and 2011.

Exhibit 3-14: SR-55 HOV Average Delay by Day of Week by Severity (2008-2011)



Source: Caltrans detector data

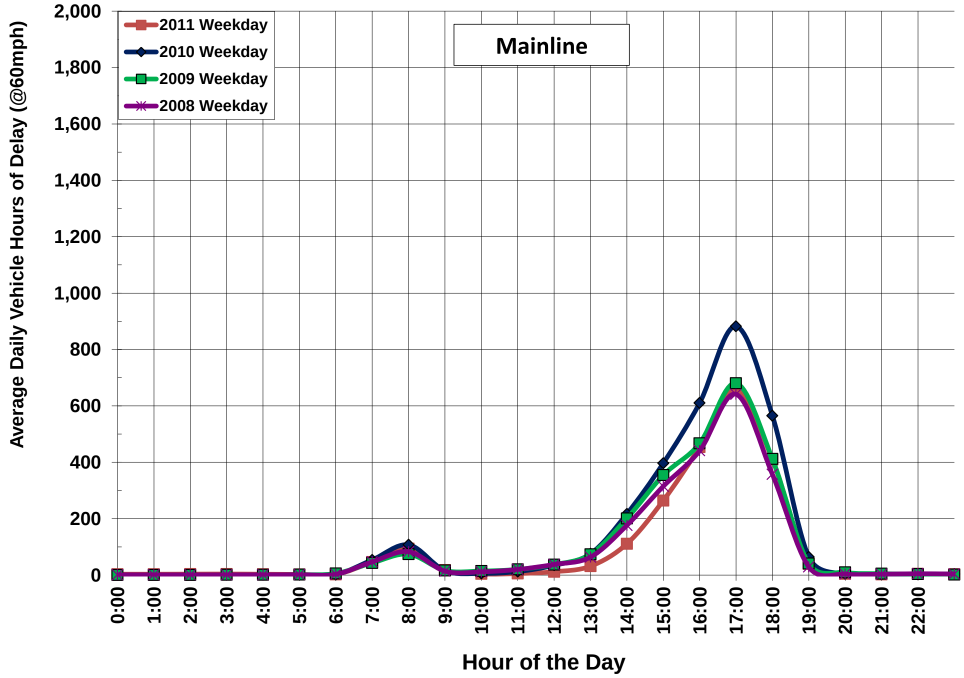
Although combating congestion requires the focus on severe congestion, it is important to review “other” congestion and understand its trends. This could allow for proactive intervention before the “other” congestion turns into severe congestion.

Another way to understand the characteristics of congestion and related delay is to examine average weekday delay by hour. The following exhibits summarize average weekday hourly delay for each year over a three-year period from 2008 to 2010. Exhibits 3-15 and 3-16 depict the mainline facility, while Exhibits 3-17 and 3-18 show the HOV facility. Each point represents the total delay for the hour. For example, the 7:00 AM point is the sum of delay from 7:00 AM to 8:00 AM. The exhibits show the peaking characteristics of congestion and how the peak period changes over time.

In the northbound direction of the mainline, delay in the PM peak exceeded delay in the AM peak. Exhibit 3-15 shows that in the northbound direction, the PM peak occurred between 2:00 PM and 7:00 PM.

During the 5:00 PM peak hour in the northbound direction of the mainline facility, Exhibit 3-15 reveals delay ranging from 640 to 680 in 2008, 2009, and 2011. It increased from 680 to 880 vehicle-hours from 2009 to 2010.

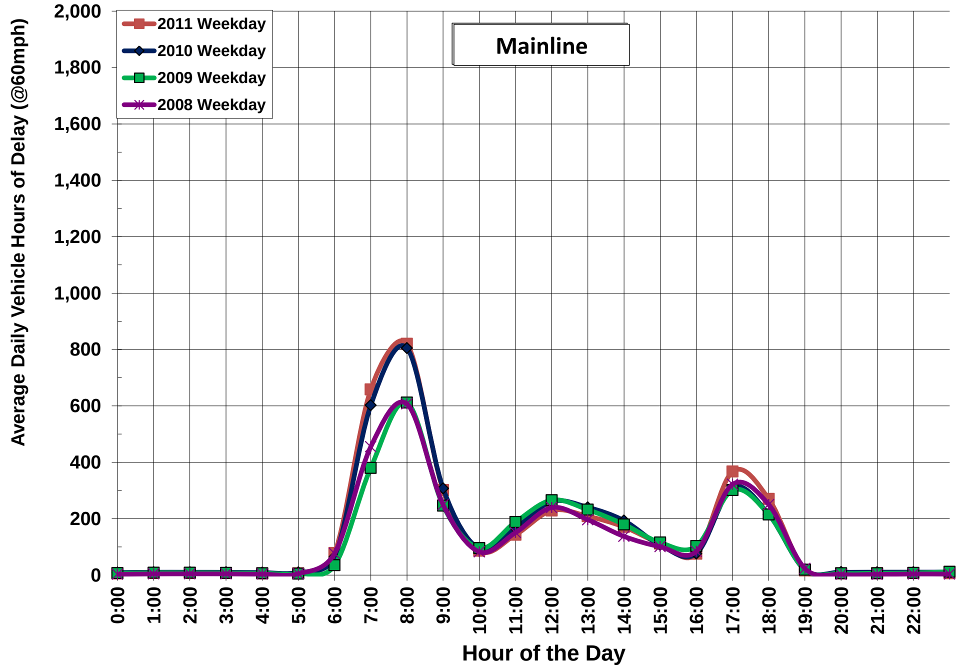
Exhibit 3-15: Northbound SR-55 ML Average Weekday Hourly Delay (2008-2011)



Source: Caltrans detector data

Exhibit 3-16 shows the hourly delay profile for the southbound direction of the mainline facility. The biggest delays occurred during the AM peak hours centered at 8:00 AM. At the 8:00 AM peak hour, 2008 and 2009 experienced similar delays of approximately 610 vehicle-hours. In 2010 however, the AM peak hour delay increased to over 800 vehicle-hours with a slight increase in 2011.

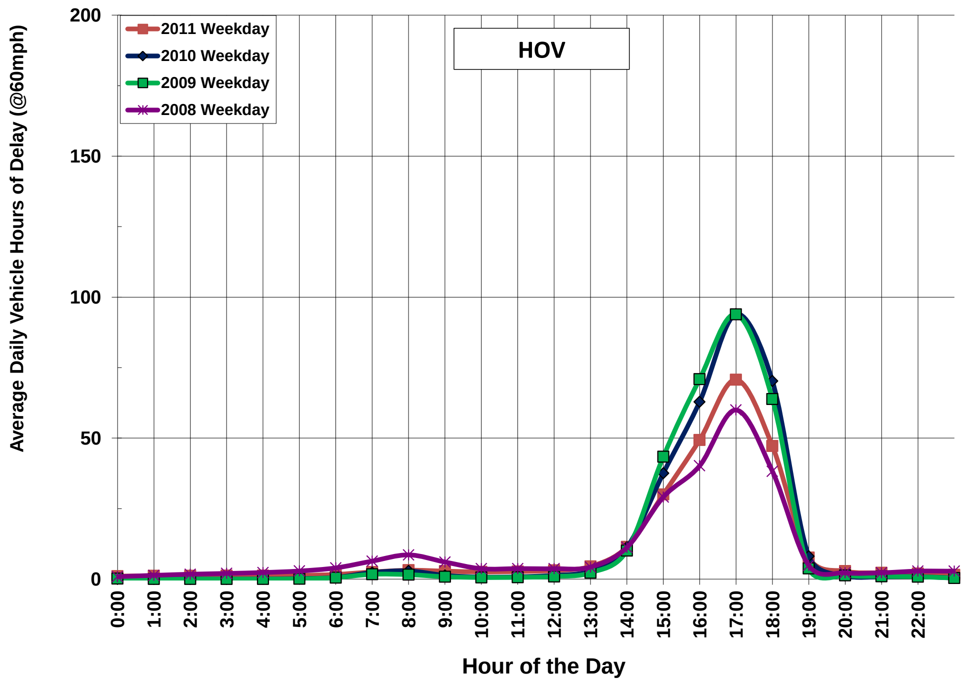
Exhibit 3-16: Southbound SR-55 ML Average Weekday Hourly Delay (2008-2011)



Source: Caltrans detector data

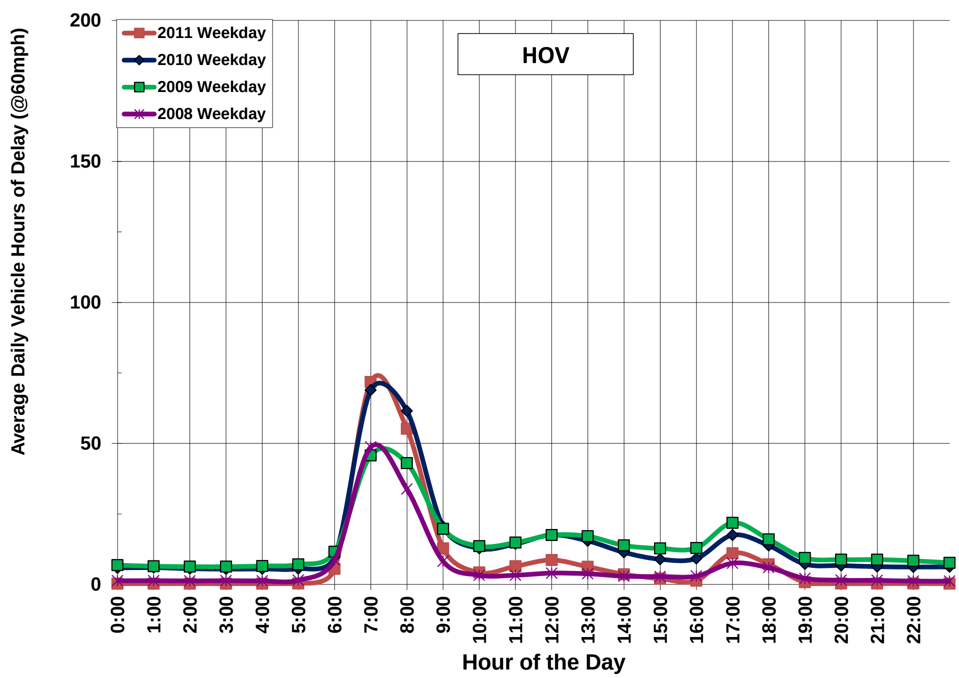
The HOV facility exhibited the same trends as the mainline facility. The northbound HOV lane experienced the most congestion during the PM peak while the southbound HOV lane experienced the most congestion during the AM peak. During the 5:00 PM peak hour in 2010, the northbound HOV lane experienced 94 vehicle-hours of delay while the southbound HOV lane experienced 72 vehicle-hours delay during the 8:00 AM peak hour in 2011.

Exhibit 3-17: Northbound SR-55 HOV Average Weekday Hourly Delay (2008-2011)



Source: Caltrans detector data

Exhibit 3-18: Southbound SR-55 HOV Average Weekday Hourly Delay (2008-2011)



Source: Caltrans detector data

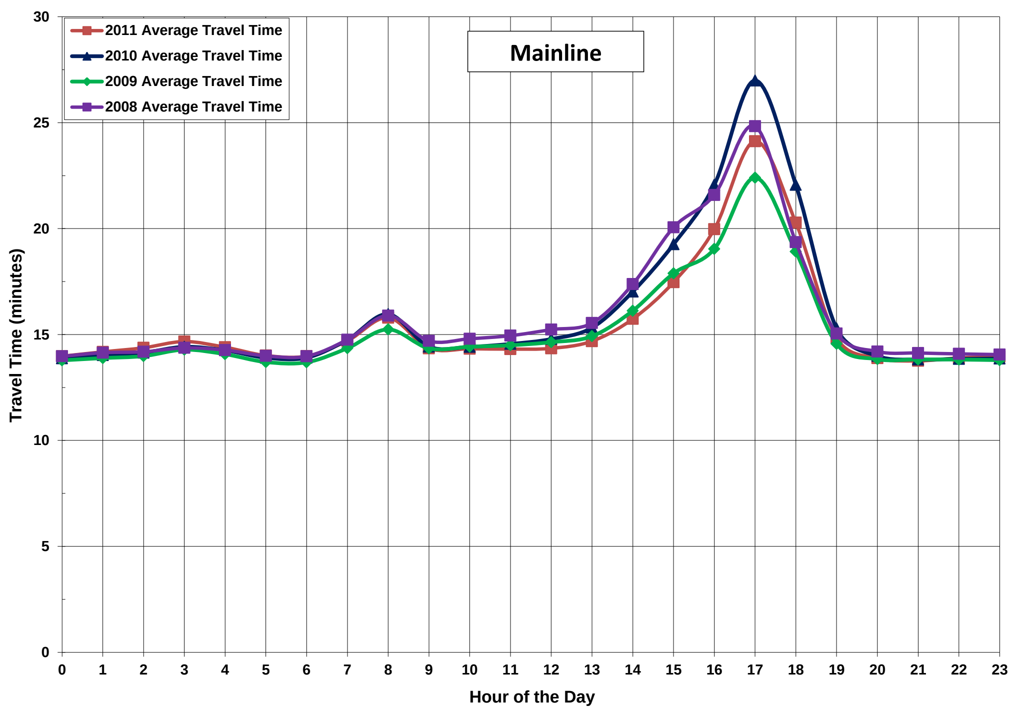
Travel Time

Travel time is reported as the amount of time it takes a vehicle to travel between two points on a corridor, as estimated using automatic detector data in this analysis. To travel the entire 15.7 miles of the mainline freeway facility, it takes approximately 16 minutes traveling at 60 mph. Travel time on parallel arterials is not included in the analysis.

Exhibits 3-19 and 3-20 summarize average annual travel times estimated for the entire mainline facility by hour of day for weekdays for the years 2008 through 2011. Similar to delay trends, travel times were highest in 2010 compared to the prior two years.

As shown in Exhibit 3-19, the northbound direction of the mainline had travel times ranging from 23 to 27 minutes during the PM peak hour. During the 5:00 PM peak hour, travel times in the northbound direction decreased from 25 minutes in 2008 to 23 minutes in 2009, and then increased to 27 minutes in 2010 and decreased to 24 minutes in 2011.

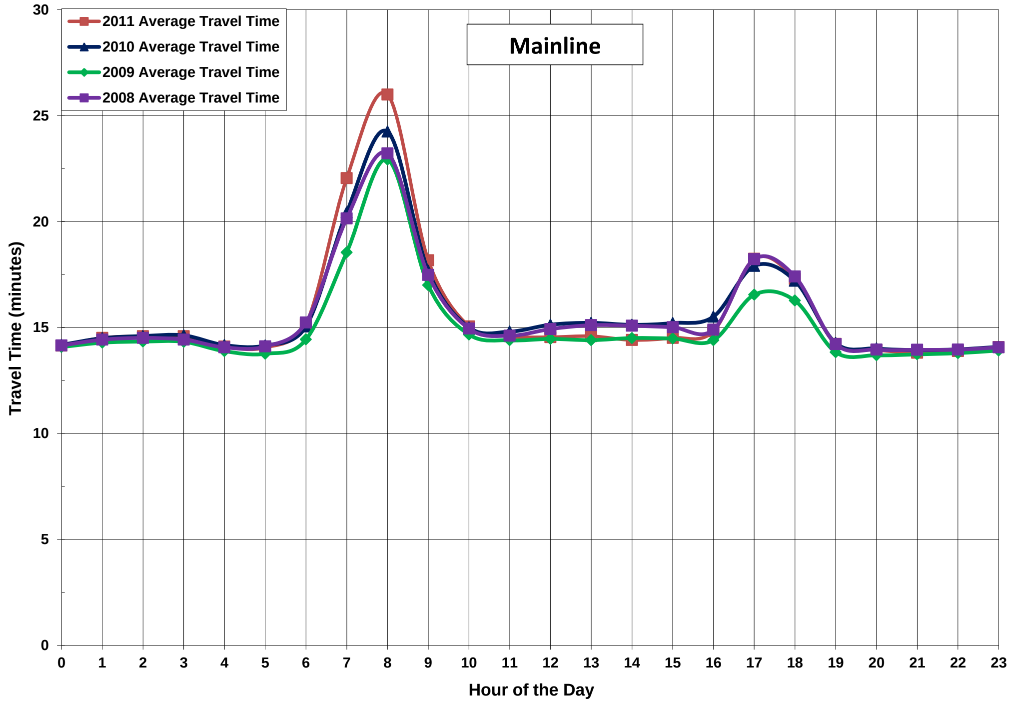
Exhibit 3-19: Northbound SR-55 ML Travel Time by Hour (2008-2011)



Source: Caltrans detector data

As shown in Exhibit 3-20, the southbound direction had travel times of approximately 23 to 26 minutes during the 8:00 AM peak hour from 2008 to 2011. Again, travel times decreased slightly from 2008 to 2009, and increased from 2009 to 2010. However, it increased to 26 minutes from 2010 to 2011.

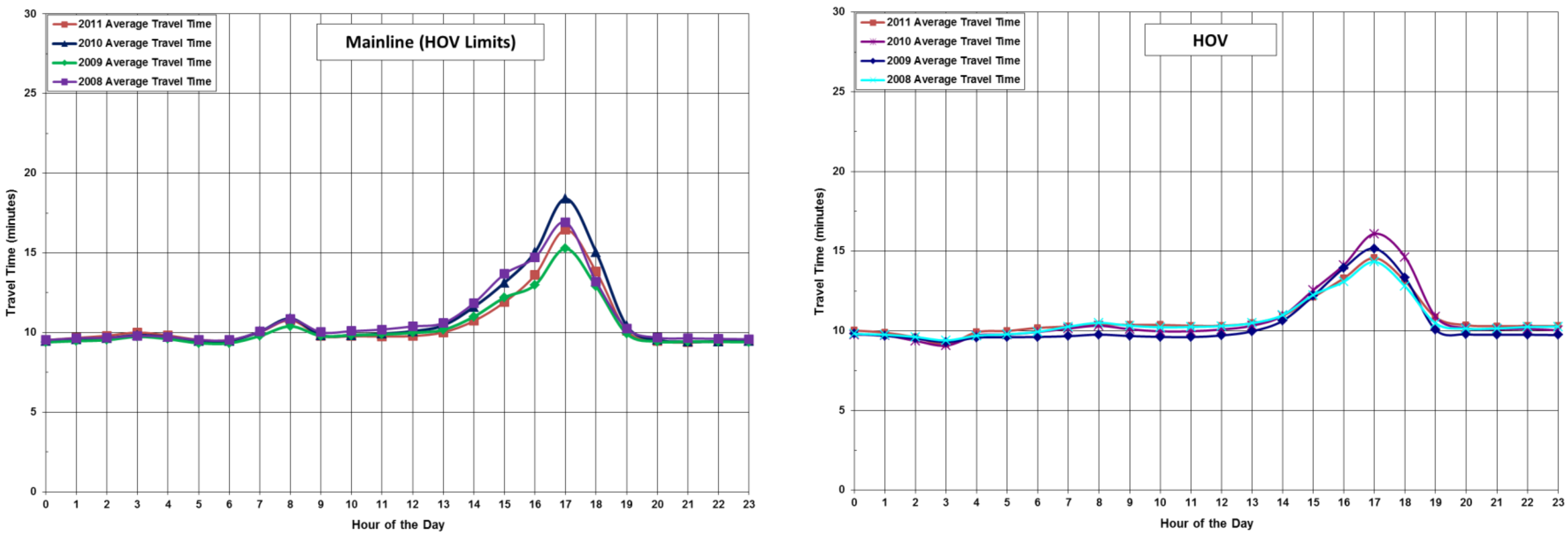
Exhibit 3-20: Southbound SR-55 ML Travel Time by Hour (2008-2011)



Source: Caltrans detector data

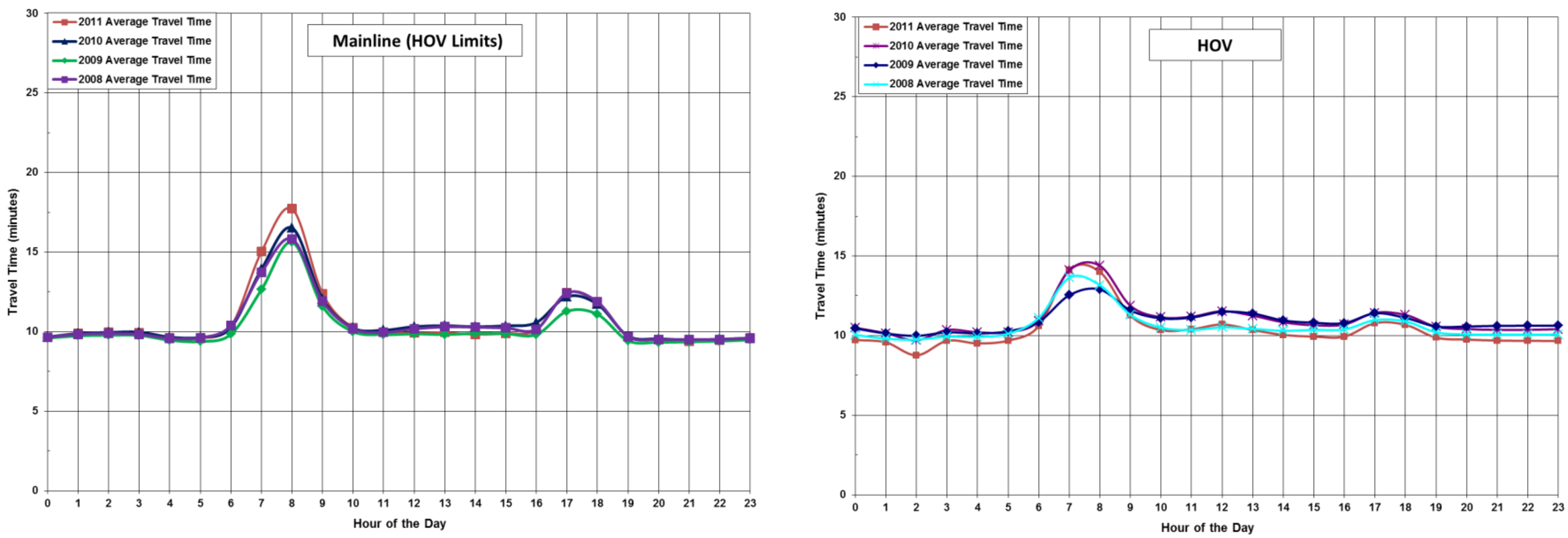
Exhibit 3-21 shows a comparison of the northbound mainline travel times within the same limits as the HOV facility and the HOV facility itself. Exhibit 3-22 shows a comparison of the southbound mainline and HOV facilities. To travel the approximately 11 miles of the HOV facility, it takes 11 minutes traveling at 60 mph. As shown in Exhibit 3-21, the northbound direction had typical travel times of approximately 15 to 18 minutes during the PM peak period for the mainline facility while the HOV travel times range from 14 to 16 minutes. Overall, 2010 experienced the highest travel times from 2008 through 2011 in the northbound direction for both the mainline and HOV facilities. In the southbound direction, 2011 experienced the highest travel times of almost 18 minutes during the 8:00 AM peak hour while travel times for the HOV facility ranged from 13 to 16 minutes.

Exhibit 3-21: Northbound SR-55 ML and HOV Travel Time by Hour (2008-2011) Comparison



Source: Caltrans detector data

Exhibit 3-22: Southbound SR-55 ML and HOV Travel Time by Hour (2008-2011) Comparison



Source: Caltrans detector data

Reliability

Reliability captures the degree of predictability in travel time. Reliability focuses on how travel time varies from day to day and reflects the impacts of accidents, incidents, weather, and special events. Improving reliability is an important goal for transportation agencies and efforts to accomplish this include incident management, traveler information, and special event planning.

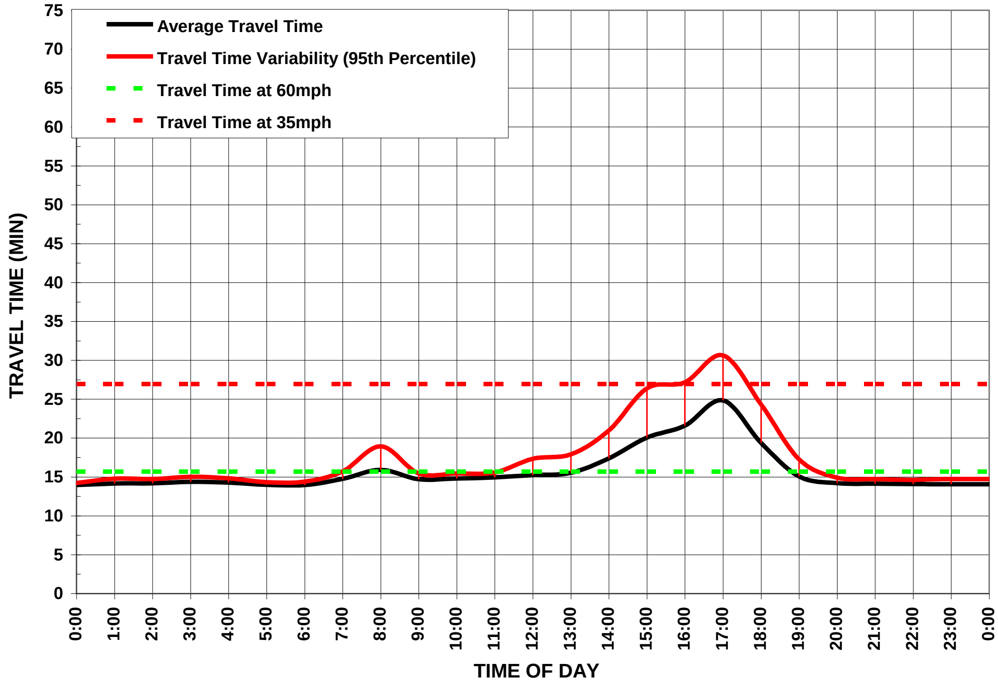
To measure reliability, the study team used automatic detector data to estimate the “buffer index.” The buffer index reflects the additional time required (over and beyond the average) to ensure an on-time arrival 95 percent of the time. In other words, if a person must be on time 95 days out of 100 (or 19 out of 20 workdays per month), then that person must add additional time to their average expected travel time to ensure an on-time arrival. That additional time is the buffer time. Severe events, such as collisions, could cause longer travel times, but the 95th percentile represents a balance between days with extreme events (e.g., major accidents) and other, more “typical” travel days.

Exhibits 3-23 through 3-46 on the following pages illustrate the variability of travel time along the SR-55 corridor on weekdays for the years 2008 through 2011.

Exhibits 3-23 through 3-30 present travel time variability for the mainline facility. In the northbound direction, the 5:00 PM peak hour was the most unreliable in addition to being the slowest hour. In 2008 (shown in Exhibit 3-23), motorists driving the entire length of the 16-mile freeway corridor had to add six minutes to an average travel time of 25 minutes (for a total travel time of 31 minutes) to ensure that they arrived on time 95 percent of the time. This is nine minutes longer than the 16-minute travel time at 60 mph. The time needed to arrive on time 95 percent of the time was also 31 minutes in 2009 and 2011 (shown in Exhibits 3-24 and 3-26) but increased to 38 minutes in 2010 (shown in Exhibit 3-25).

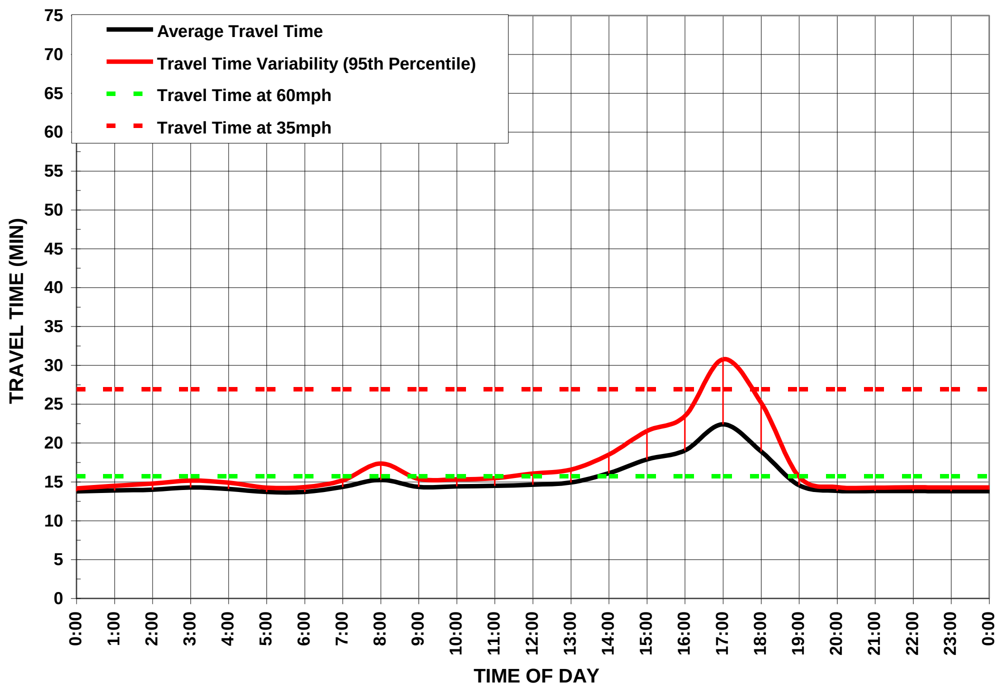
In the southbound direction of the mainline facility, the most unreliable hours were 8:00 AM and around 5:30 PM. Unlike the northbound direction which experienced the highest travel time variability during the PM peak period, the southbound direction experienced high travel time variability during both AM and PM peak periods. In 2008 (Exhibit 3-27), the time needed to arrive on time 95 percent of the time was 34 minutes at 8:00 AM and 30 minutes at 5:30 PM. Variability in travel times decreased in 2009 (Exhibit 3-28) to 31 minutes and 24 minutes for the AM and PM peak hour respectively. In 2010, travel time variability (Exhibit 3-29) increased to 33 minutes at 8:00 AM but decreased to 26 minutes at the 5:30 PM peak hour. In 2011, AM peak hour travel time variability increased to 34 minutes while the PM peak hour travel time variability reached 30 minutes (Exhibit 3-30).

Exhibit 3-23: Northbound SR-55 ML Travel Time Variation (2008)



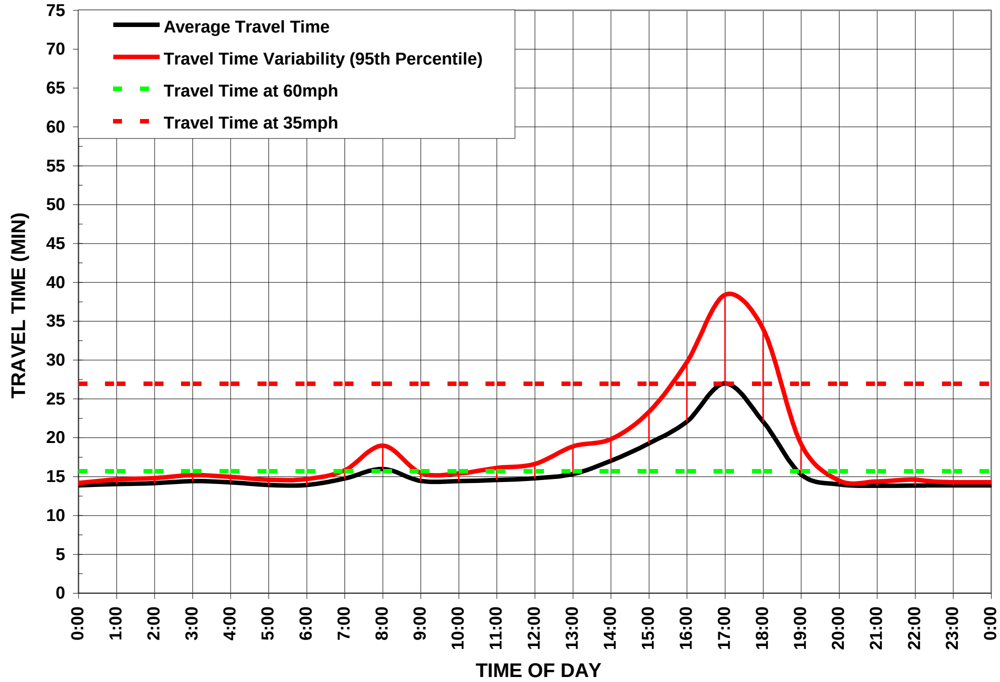
Source: Caltrans detector data

Exhibit 3-24: Northbound SR-55 ML Travel Time Variation (2009)



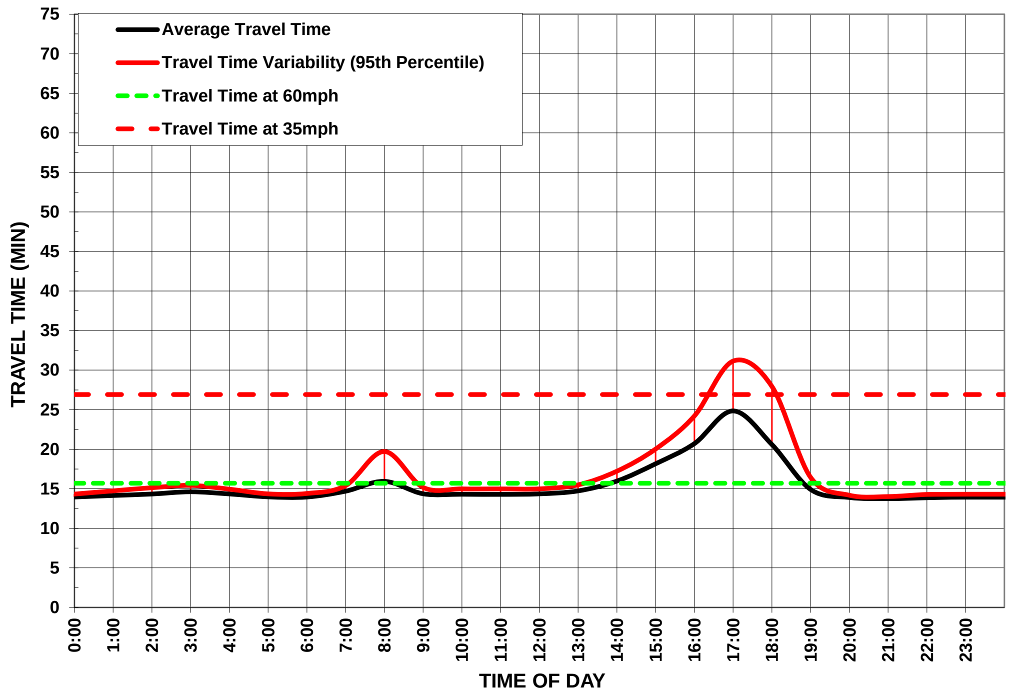
Source: Caltrans detector data

Exhibit 3-25: Northbound SR-55 ML Travel Time Variation (2010)



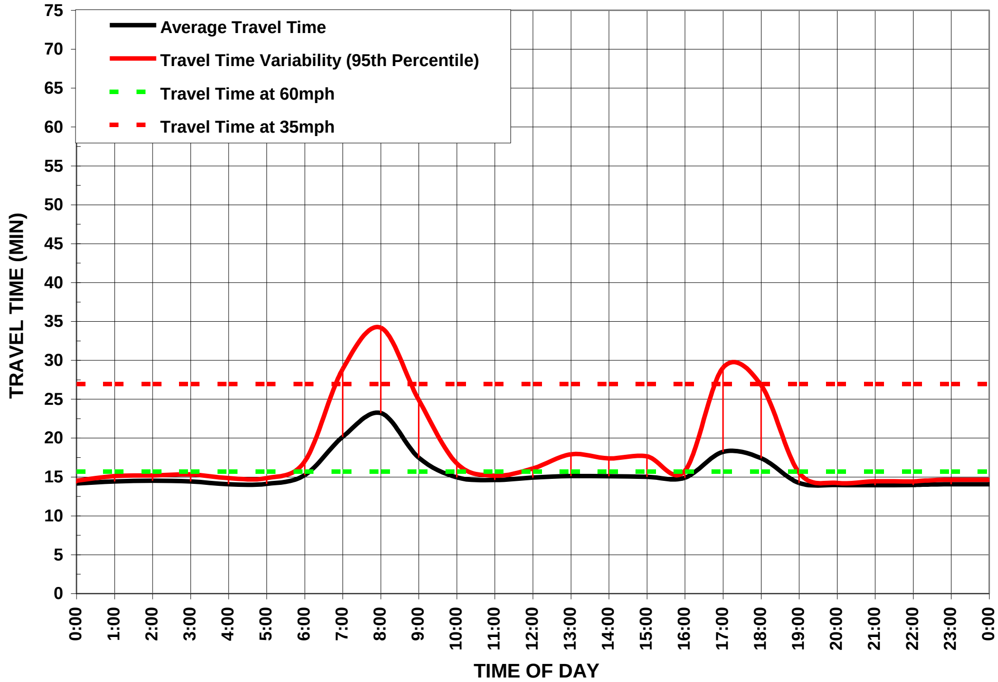
Source: Caltrans detector data

Exhibit 3-26: Northbound SR-55 ML Travel Time Variation (2011)



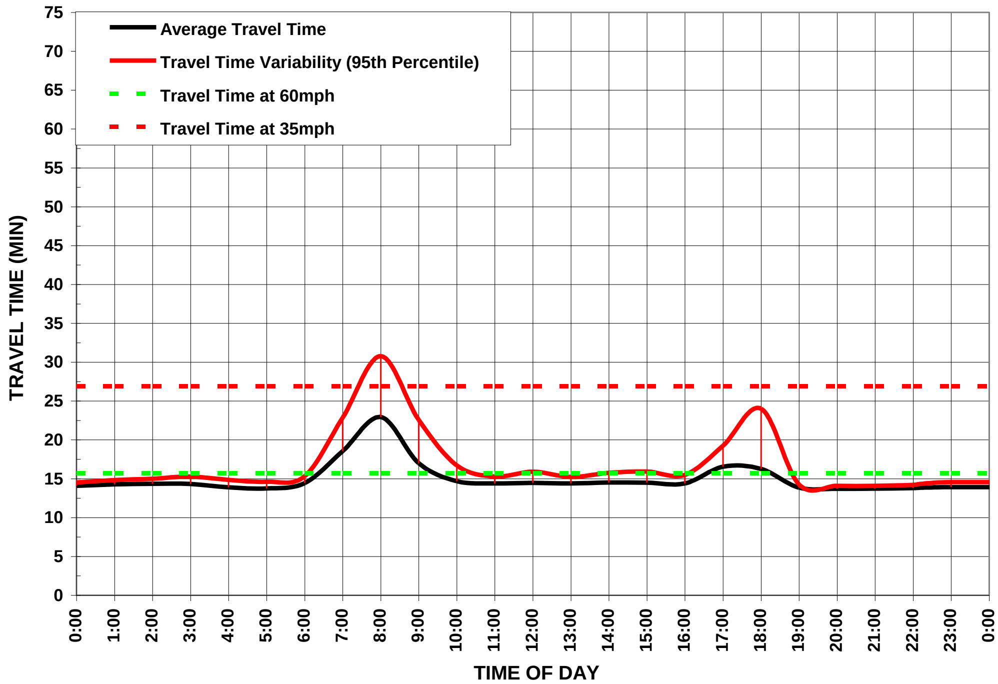
Source: Caltrans detector data

Exhibit 3-27: Southbound SR-55 ML Travel Time Variation (2008)



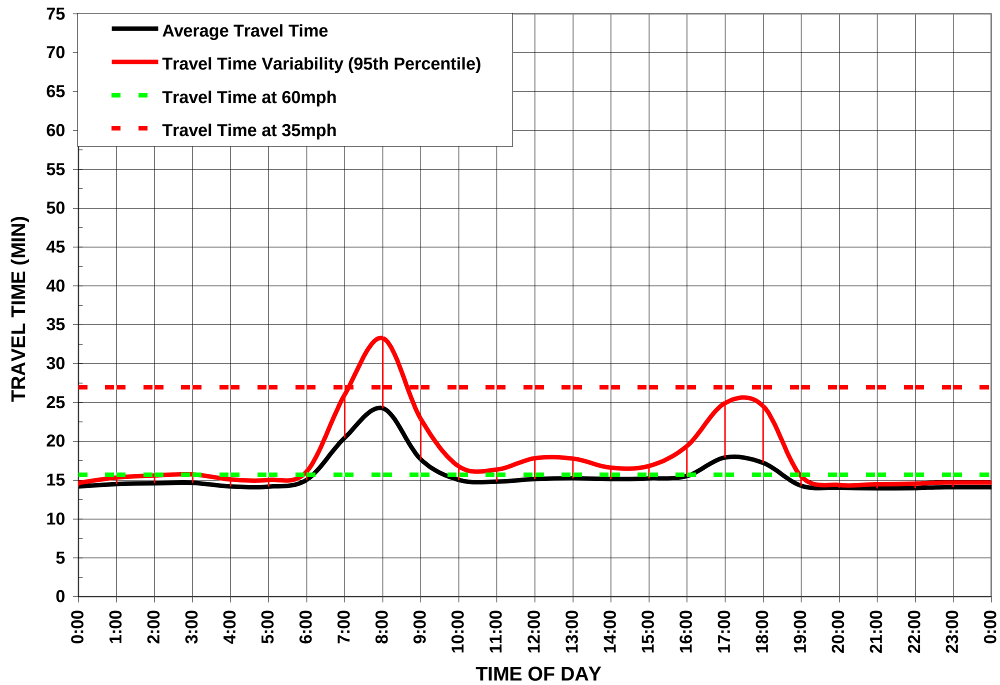
Source: Caltrans detector data

Exhibit 3-28: Southbound SR-55 ML Travel Time Variation (2009)



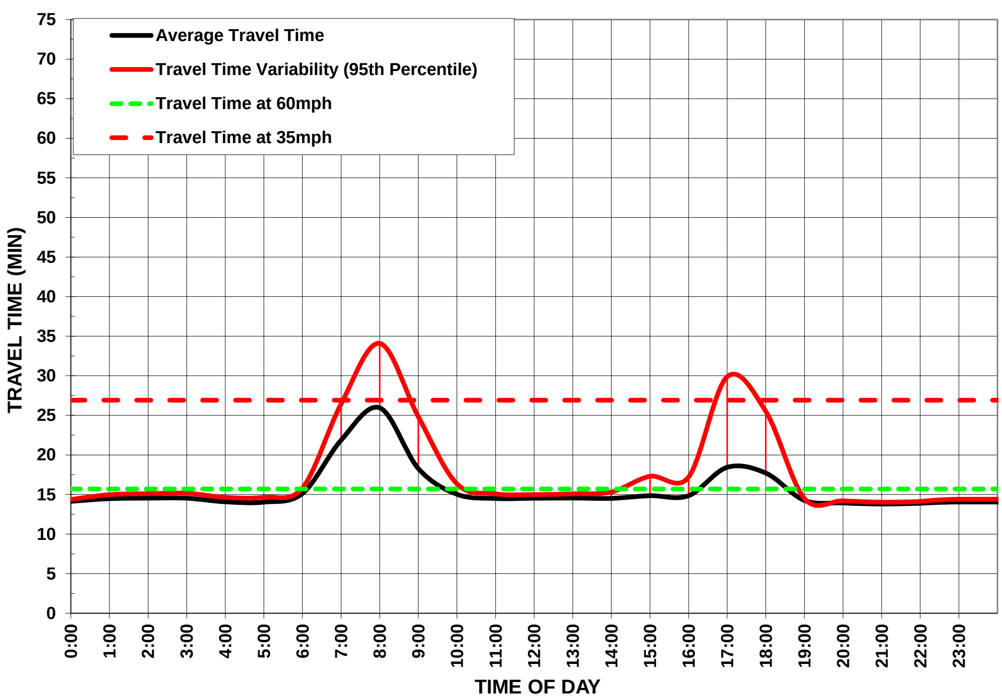
Source: Caltrans detector data

Exhibit 3-29: Southbound SR-55 ML Travel Time Variation (2010)



Source: Caltrans detector data

Exhibit 3-30: Southbound SR-55 ML Travel Time Variation (2011)



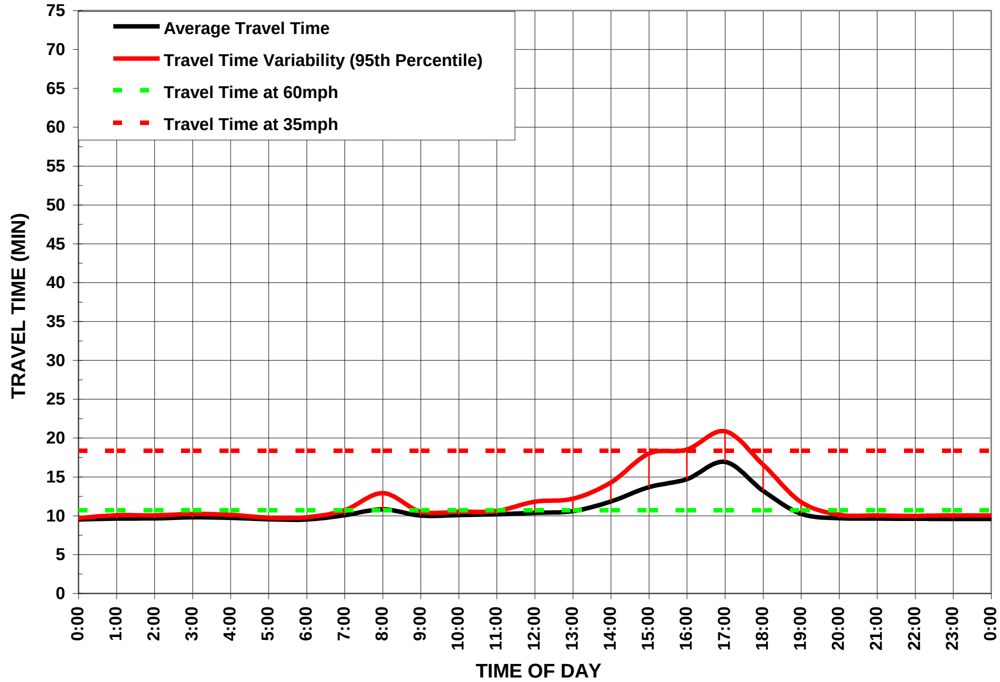
Source: Caltrans detector data

Exhibits 3-31 through 3-38 present travel time variability for the mainline facility within the HOV facility limits while Exhibits 3-39 to 3-46 present travel time variability for the HOV facility. In the northbound direction of the HOV lane, the average travel time it takes to travel the 11-mile HOV facility varies from 14 minutes in 2008, to 15 minutes in 2009 and 2011, and 16 minutes in 2010 during the 5:00 PM peak hour, which is the unreliable and slowest hour. Similarly for the mainline facility within the same limits, while average travel times ranged from 15 to 18 minutes, the 5:00 PM peak hour was also the most unreliable and slowest hour. The time needed to arrive on time 95 percent of the time during this peak hour of travel was 19 minutes in 2008, 27 minutes in 2009, and 26 minutes in 2010 for the HOV facility. HOV travel time variability was highest in 2009 and the same in 2010 as the mainline facility. In 2011, travel time variability was 19 minutes and 21 minutes for the HOV and mainline facility, respectively.

In the southbound direction, the most unreliable hour occurs at 7:30 AM for the HOV facility and at 8:00 AM for the mainline. For the HOV facility during the 7:30 AM peak hour in 2008, motorists had to add three minutes to an average travel time of 14 minutes (for a total travel time of 17 minutes) to ensure they arrived on time 95 percent of the time. This is six minutes longer than the 11-minute travel time at 60 mph. In 2009, the time needed to arrive on time 95 percent of the time increased by one minute to 18 minutes, decreased to slightly over 15 minutes in 2010, and increased to 17 minutes in 2011. For the mainline, while average travel time was around 16 to 18 minutes for all four years, to ensure on time arrival, motorists, must add five to eight minutes (for a total travel time of 24 minutes).

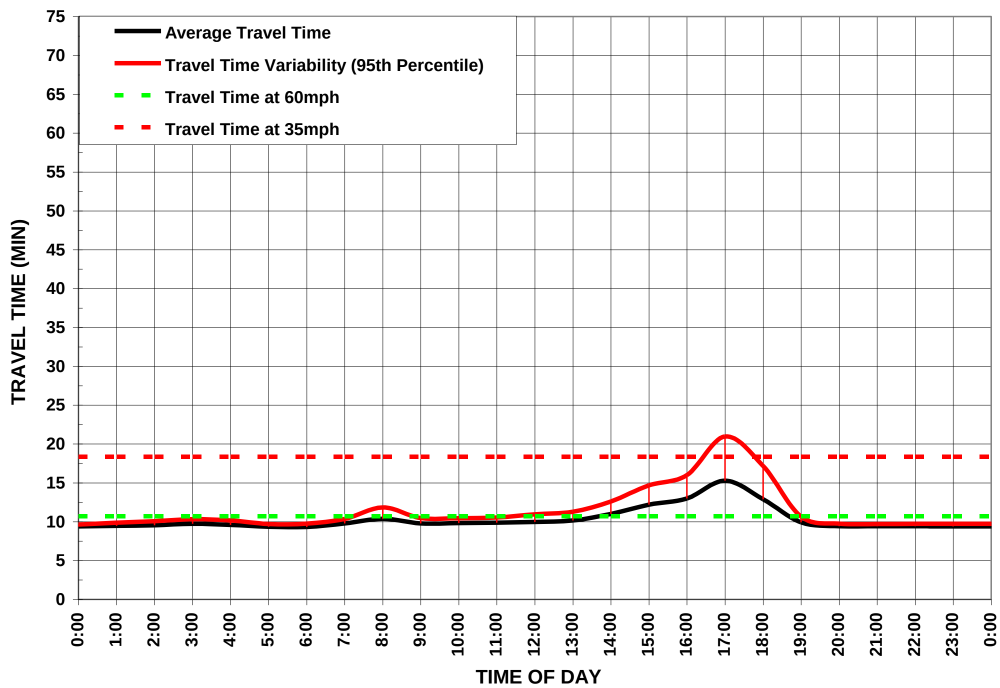
Currently, there are several efforts underway to better evaluate the causality of unreliability and to estimate the potential benefits of treatments to improve reliability on freeways. This second Strategic Highway Research Program (SHRP 2) of the National Academy of Sciences (NAS) Transportation Research Board (TRB) is developing tools with the potential for evaluating projects in terms of reliability benefits. At this time, these tools are being tested and have not been implemented.

Exhibit 3-31: Northbound SR-55 ML (HOV Limits) Travel Time Variation (2008)



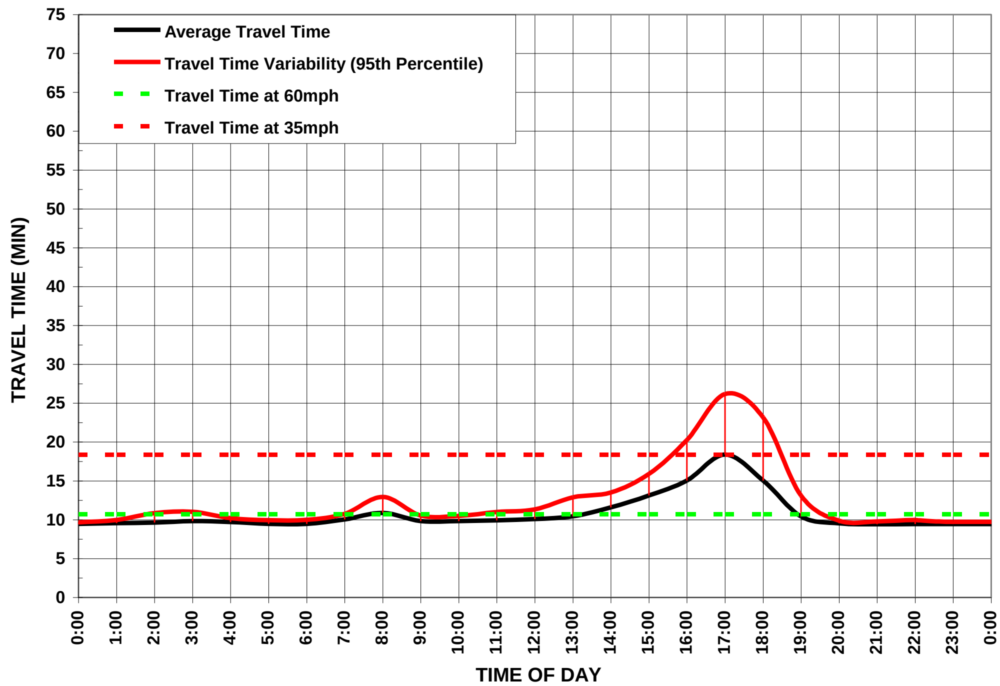
Source: Caltrans detector data

Exhibit 3-32: Northbound SR-55 ML (HOV Limits) Travel Time Variation (2009)



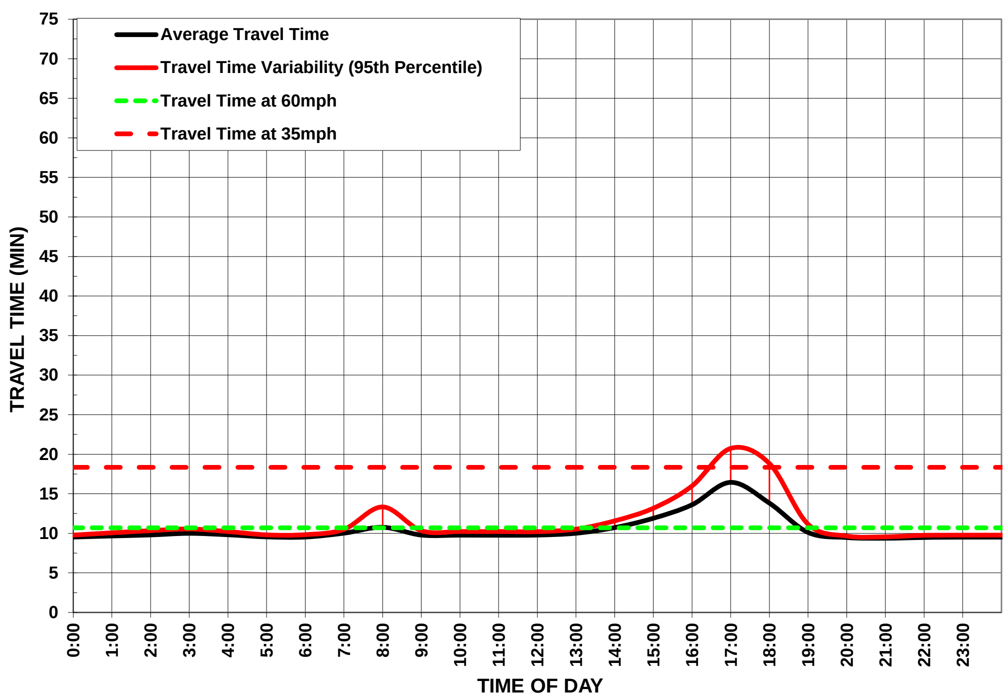
Source: Caltrans detector data

Exhibit 3-33: Northbound SR-55 ML (HOV Limits) Travel Time Variation (2010)



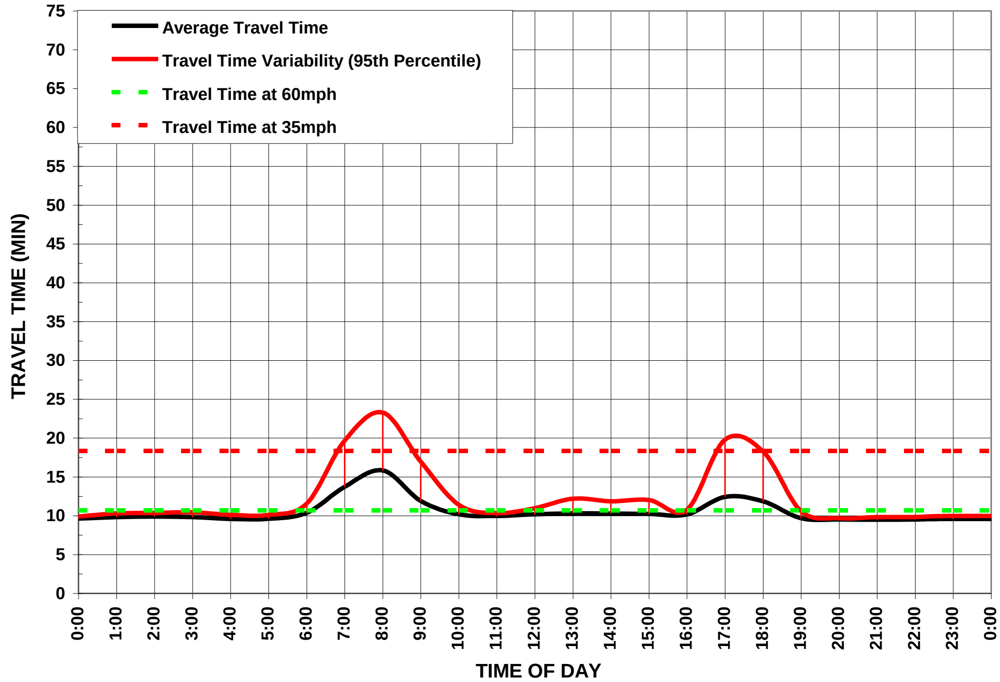
Source: Caltrans detector data

Exhibit 3-34: Northbound SR-55 ML (HOV Limits) Travel Time Variation (2011)



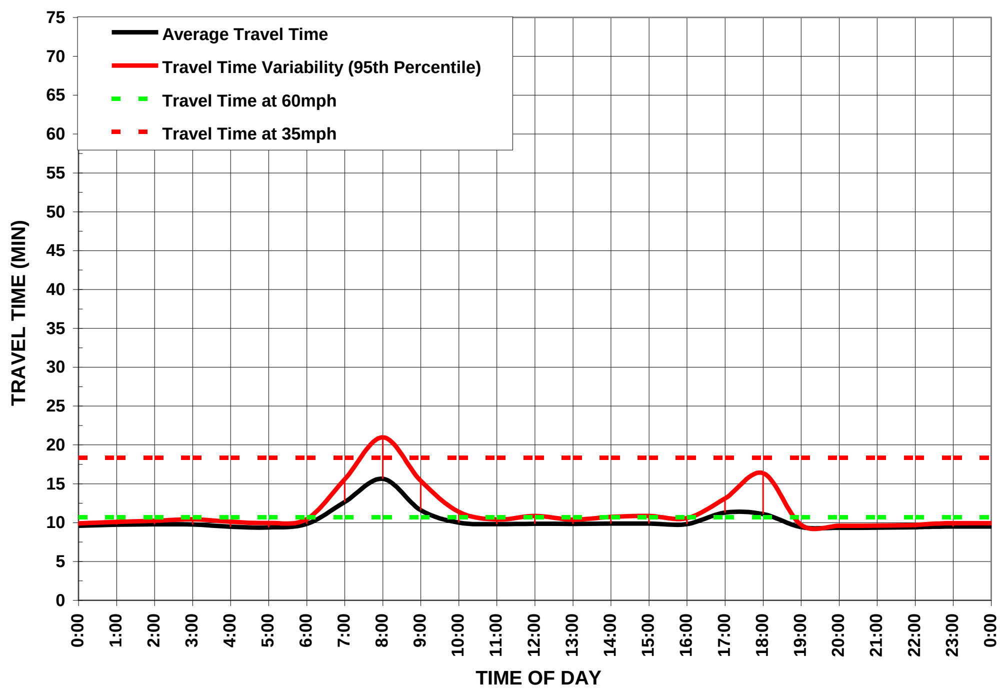
Source: Caltrans detector data

Exhibit 3-35: Southbound SR-55 ML (HOV Limits) Travel Time Variation (2008)



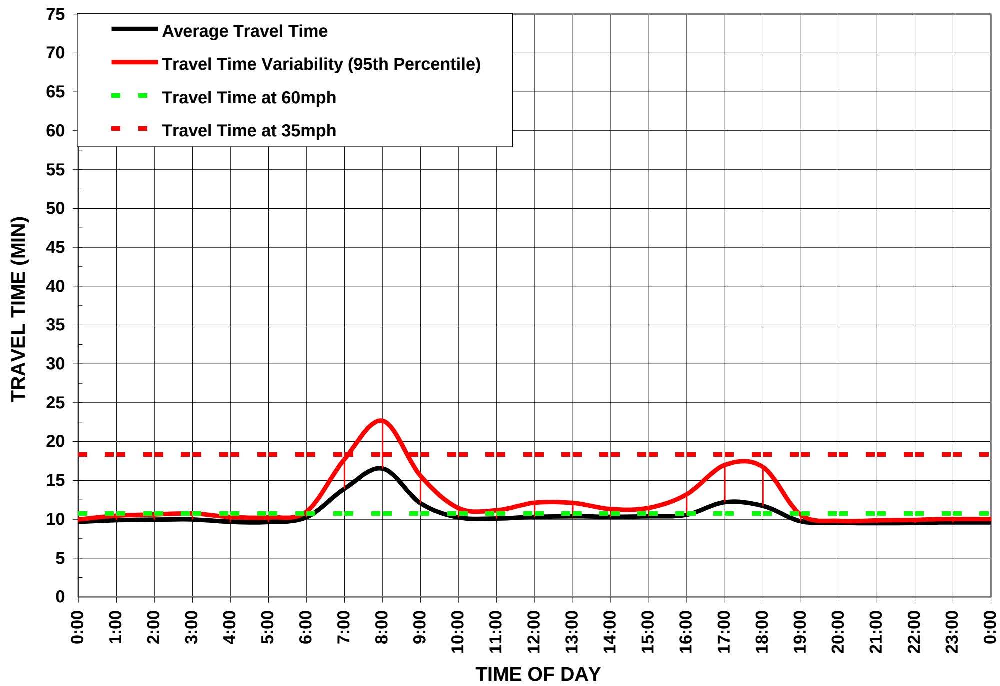
Source: Caltrans detector data

Exhibit 3-36: Southbound SR-55 ML (HOV Limits) Travel Time Variation (2009)



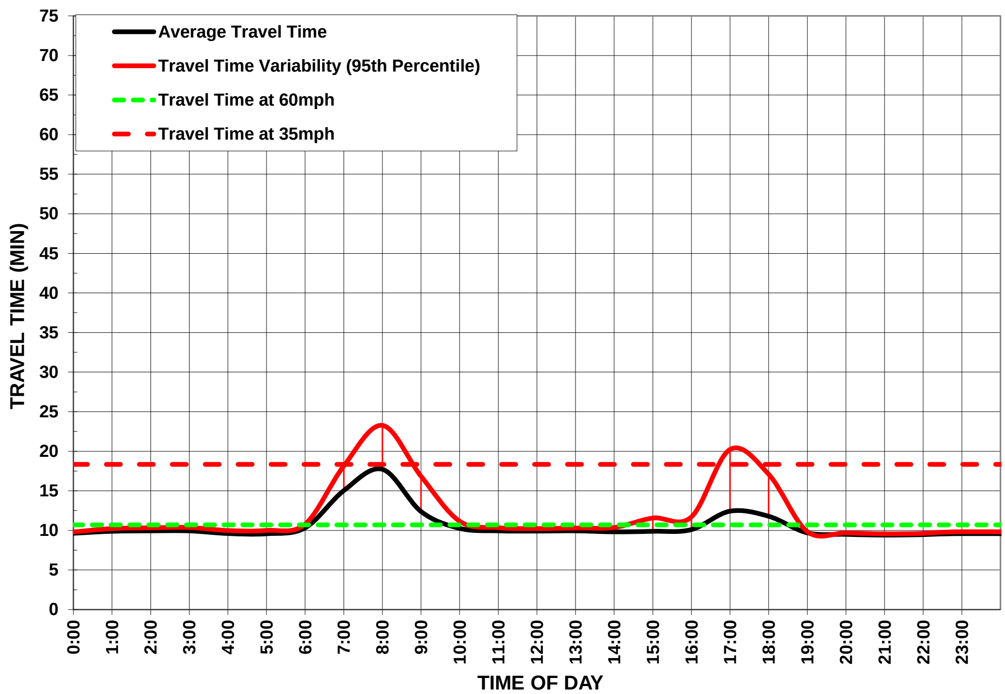
Source: Caltrans detector data

Exhibit 3-37: Southbound SR-55 ML (HOV Limits) Travel Time Variation (2010)



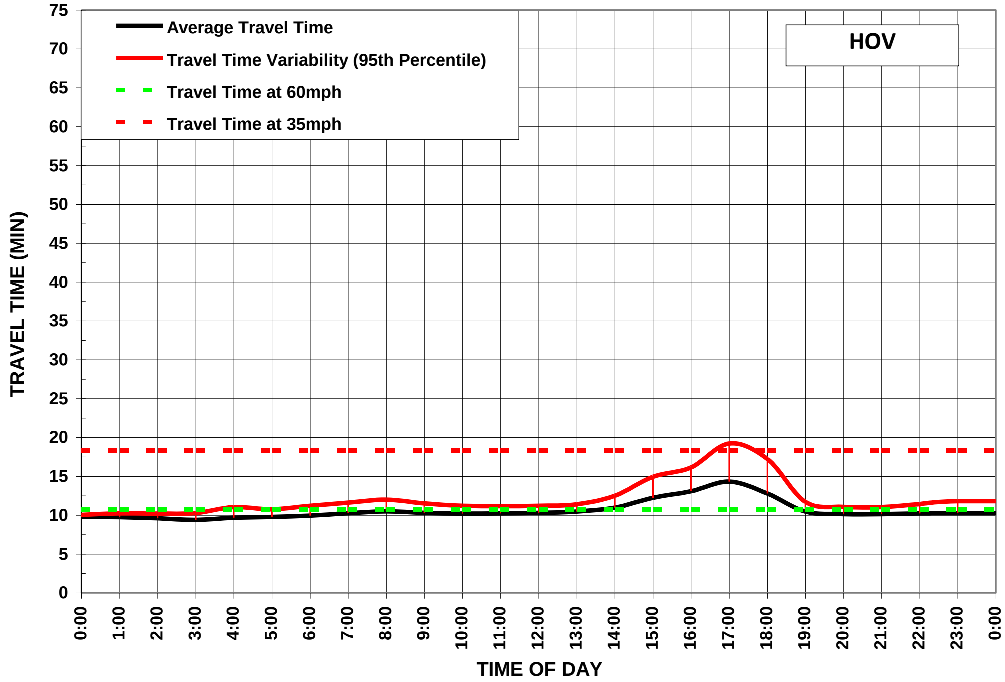
Source: Caltrans detector data

Exhibit 3-38: Southbound SR-55 ML (HOV Limits) Travel Time Variation (2011)



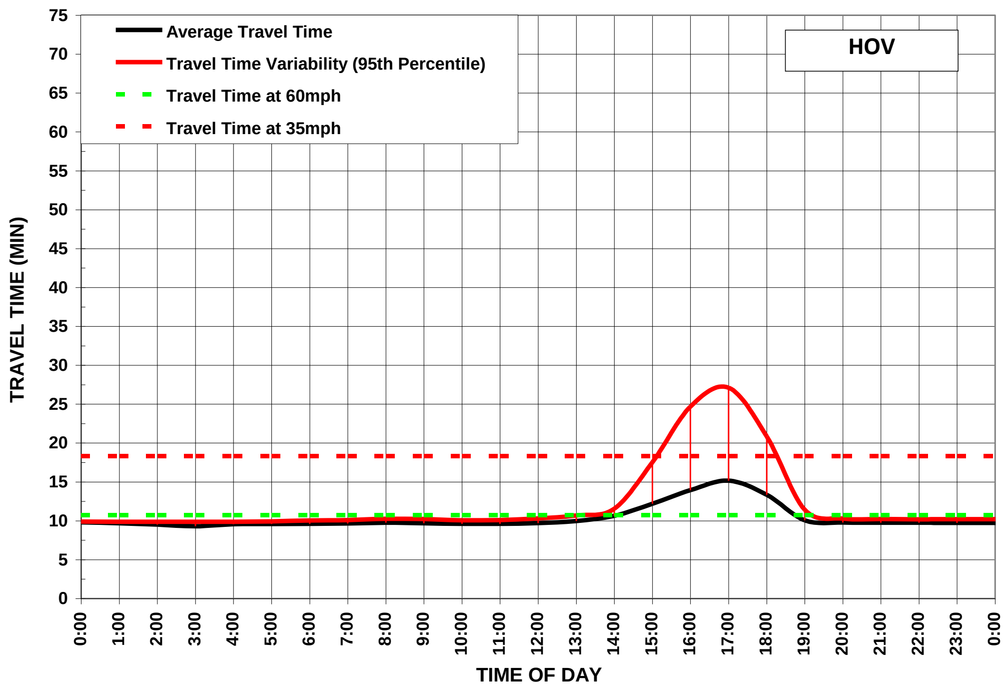
Source: Caltrans detector data

Exhibit 3-39: Northbound SR-55 HOV Travel Time Variation (2008)



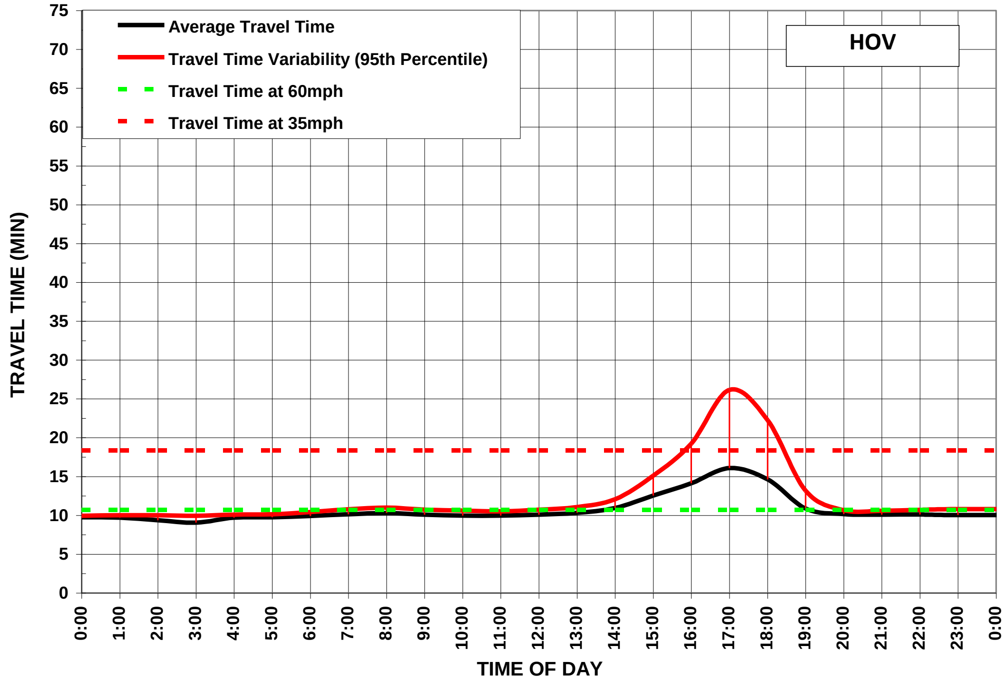
Source: Caltrans detector data

Exhibit 3-40: Northbound SR-55 HOV Travel Time Variation (2009)



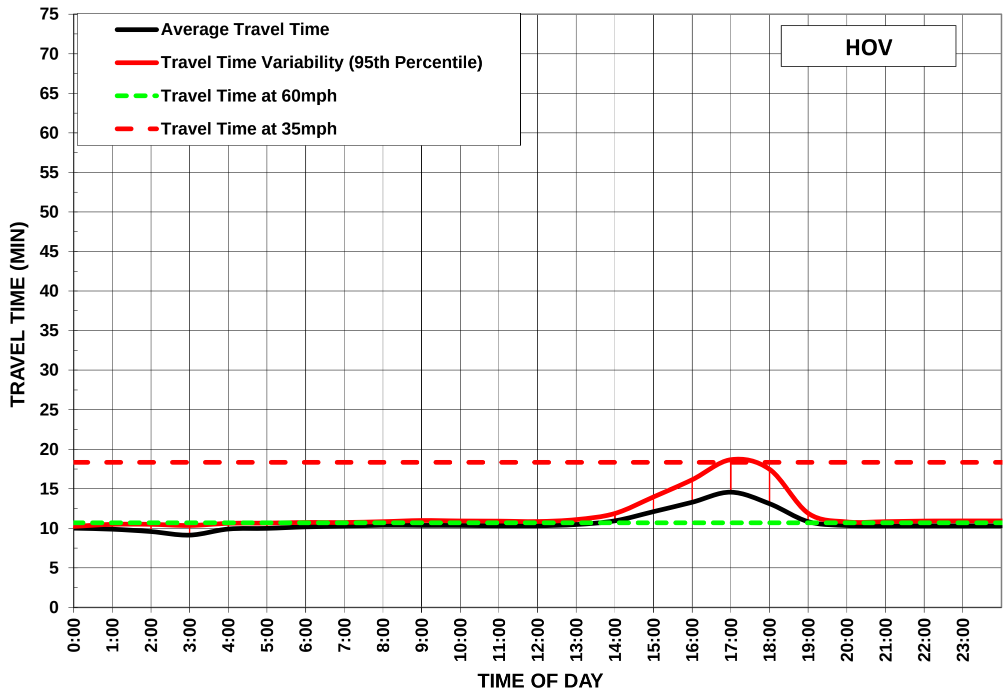
Source: Caltrans detector data

Exhibit 3-41: Northbound SR-55 HOV Travel Time Variation (2010)



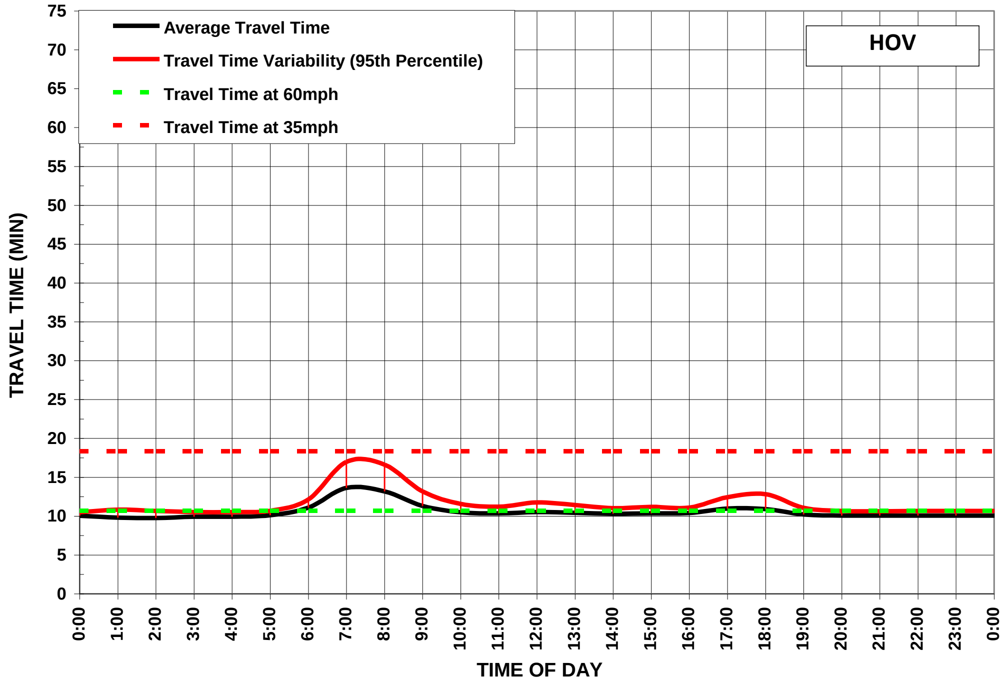
Source: Caltrans detector data

Exhibit 3-42: Northbound SR-55 HOV Travel Time Variation (2011)



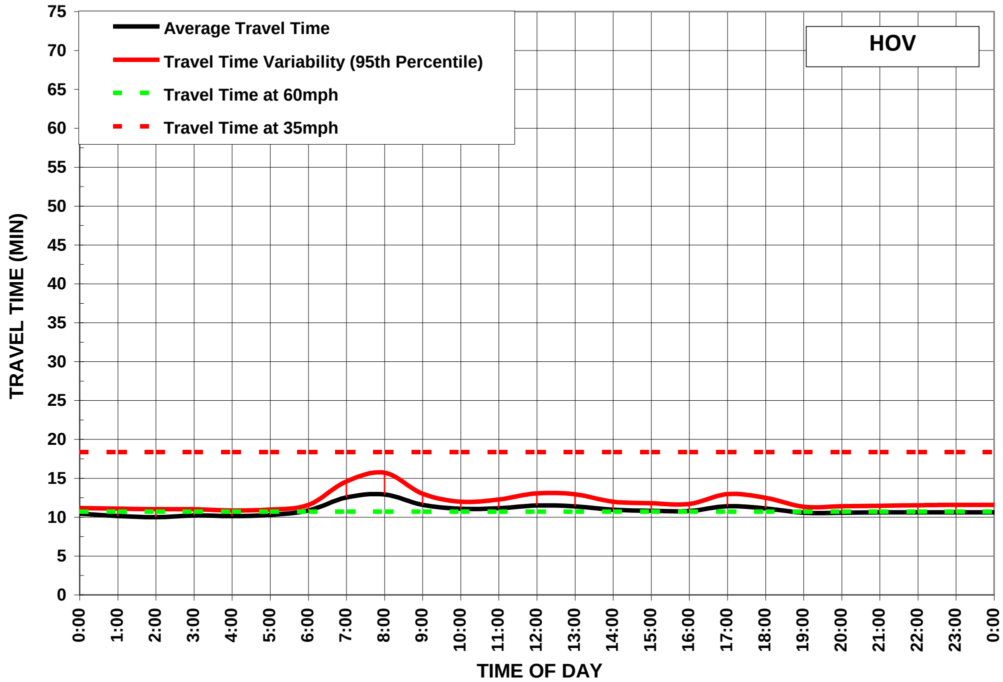
Source: Caltrans detector data

Exhibit 3-43: Southbound SR-55 HOV Travel Time Variation (2008)



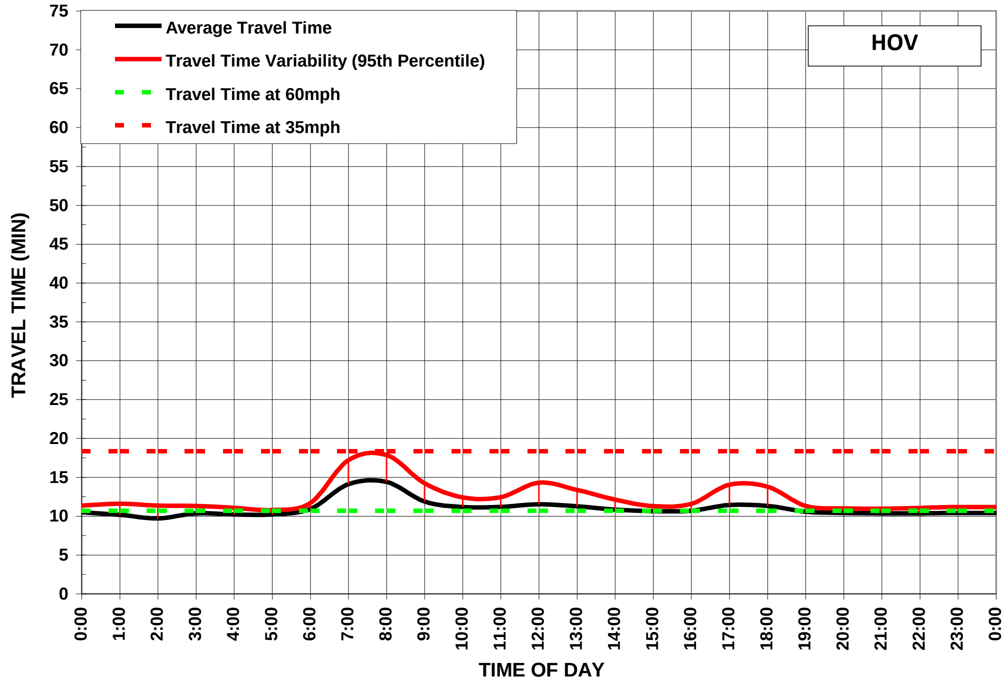
Source: Caltrans detector data

Exhibit 3-44: Southbound SR-55 HOV Travel Time Variation (2009)



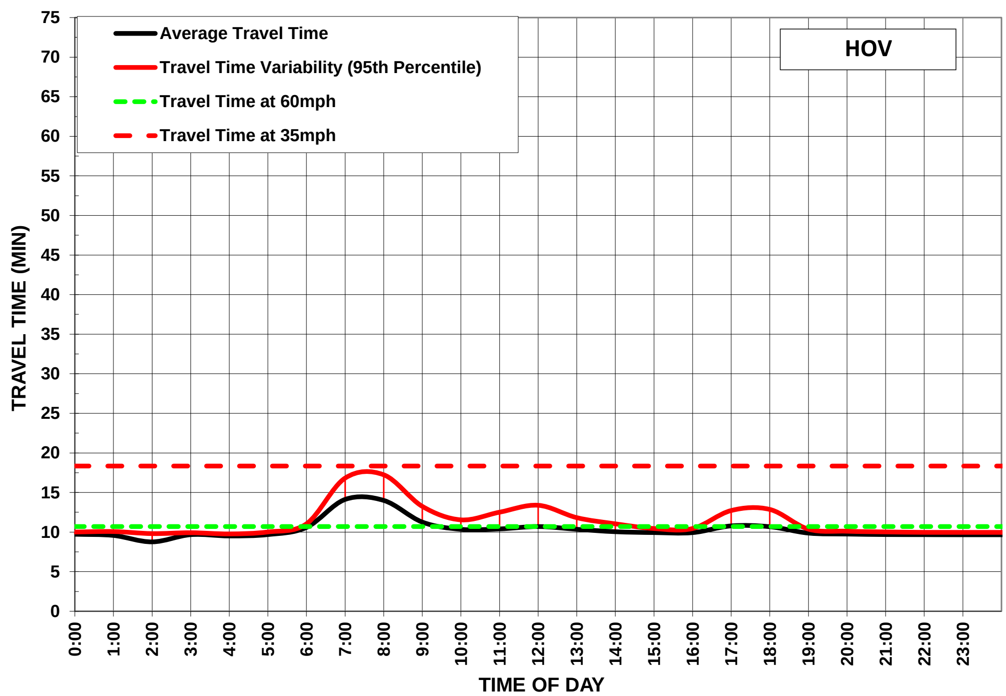
Source: Caltrans detector data

Exhibit 3-45: Southbound SR-55 HOV Travel Time Variation (2010)



Source: Caltrans detector data

Exhibit 3-46: Southbound SR-55 HOV Travel Time Variation (2011)



Source: Caltrans detector data

Safety

Collision data in terms of the number of accidents and accident rates from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS) were used for the safety measure. TASAS is a traffic records system containing an accident database linked to a highway database. The highway database contains descriptive elements of highway segments, intersections and ramps, access control, traffic volumes and other data. TASAS contains specific data for accidents on state highways. Accidents on non-state highways are not included (e.g., local streets and roads).

The safety assessment in this report is intended to characterize the overall accident history and trends in the corridor, and to highlight notable accident concentration locations or patterns that are readily apparent. This report is not intended to supplant more detailed safety investigations routinely performed by Caltrans staff.

Exhibit 3-47 shows the latest available three-year TASAS Table B accident rates for the SR-55 mainline facility from July 1, 2007 to June 30, 2010, divided by direction and accident rate groups. It also shows the average accident rates experienced on facilities with similar operating characteristics. As indicated in this exhibit, the total average accident rates range from 0.78 to 2.35 accidents per million vehicle miles. The northbound segment south of Fair Drive to north of Mesa Drive (PM R3.200 to PM R4.299) and the southbound segment south of Collins Avenue to south of Santiago Creek (PM 14.499 to PM 13.300) have the lowest average accident rate of 0.78, while the northbound and southbound segments from Newport Beach Channel to SR-1 (PM 0.175 to PM 0.348) have the highest average accident rate of 2.35 for the corridor. Although the majority of SR-55 segments actual accident rates were below average rates on similar facilities, both the northbound and southbound segments from south of 17^{th} Street to Victoria Street/22^{nd} Street (PM 1.300 to PM 2.067) have actual accident rates that exceed the average accident rates by up to 2.35 accidents per million vehicle miles. While injury rates were higher in these two segments, most of the increased total accident rates were due to property damages only accidents. With the recently completed widening project in this segment of SR-55 however, the resulting expanded capacity could also result in improved safety.

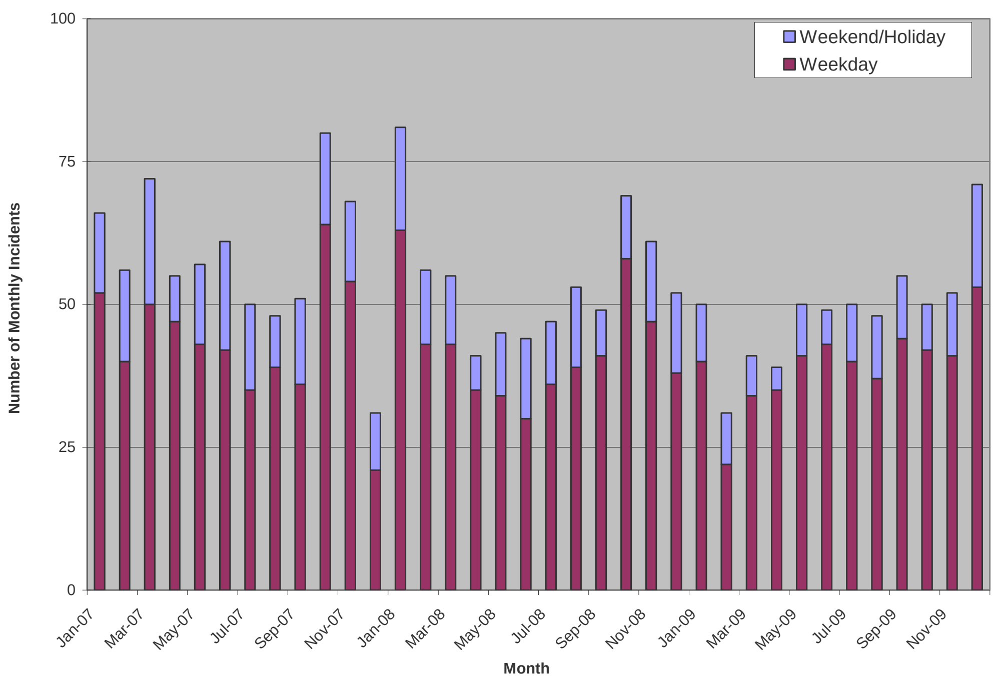
Exhibit 3-47: Table B Accident Rates (July 1, 2007 to June 30, 2010)

Dir	Segment		Accident Rates					
			Actual Rates on SR-55			Average Rates on Similar Facilities		
	From PM	From PM	Fat	F+I	Tot	Fat	F+I	Tot
NB	0.000	0.174	0.000	0.00	0.22	0.018	0.71	1.75
	0.175	0.348	0.000	0.00	0.52	0.024	0.97	2.35
	0.349	0.549	0.000	0.17	0.34	0.013	0.53	1.30
	0.550	1.299	0.000	**0.76**	**1.21**	0.011	0.43	1.05
	1.300	2.067	0.000	**1.65**	**3.98**	0.016	0.72	1.63
	2.068	R3.199	0.000	0.15	0.39	0.009	0.32	0.93
	R3.200	R4.299	0.000	0.09	0.55	0.008	0.24	0.78
	R4.300	R5.299	0.000	0.24	0.76	0.010	0.31	1.01
	R5.300	R6.599	0.000	**0.40**	**1.22**	0.010	0.30	0.96
	R6.600	R7.399	0.000	**0.38**	**1.46**	0.010	0.30	1.01
	R7.400	R8.399	0.000	0.29	**1.13**	0.011	0.34	1.12
	R8.400	R9.499	0.000	0.26	0.74	0.011	0.34	1.10
	R9.500	11.299	0.004	0.28	0.90	0.010	0.31	1.05
	11.300	12.299	0.000	0.15	0.62	0.011	0.33	1.09
	12.300	13.299	0.000	0.13	0.47	0.011	0.36	1.14
	13.300	14.499	0.013	0.19	0.62	0.012	0.37	1.21
	14.500	16.199	0.000	0.18	0.61	0.012	0.36	1.17
	16.200	R17.875	0.016	0.21	0.86	0.012	0.38	1.23
SB	R17.875	16.200	0.000	0.08	0.40	0.012	0.38	1.23
	16.199	14.500	0.000	0.32	**1.53**	0.009	0.32	0.93
	14.499	13.300	0.000	0.17	0.59	0.008	0.24	0.78
	13.299	12.300	0.000	0.14	0.45	0.010	0.31	1.01
	12.299	11.300	0.000	0.25	0.85	0.010	0.30	0.96
	11.299	R9.500	0.000	0.25	**1.03**	0.010	0.30	1.01
	R9.499	R8.400	0.000	0.27	0.89	0.011	0.34	1.12
	R8.399	R7.400	0.000	0.21	0.85	0.011	0.34	1.10
	R7.399	R6.600	0.000	**0.36**	**1.51**	0.010	0.31	1.05
	R6.599	R5.300	0.000	0.26	**1.13**	0.011	0.33	1.09
	R5.299	R4.300	**0.024**	**0.38**	**1.19**	0.011	0.36	1.14
	R4.299	R3.200	0.000	0.29	1.12	0.012	0.37	1.21
	R3.199	2.068	0.000	0.13	0.52	0.012	0.36	1.17
	2.067	1.300	**0.032**	**1.07**	**3.78**	0.016	0.72	1.63
	1.299	0.550	0.000	0.40	0.90	0.011	0.43	1.05
	0.549	0.349	0.000	0.17	0.34	0.013	0.53	1.30
	0.348	0.175	0.000	0.00	0.52	0.024	0.97	2.35
	0.174	0.000	0.000	0.44	0.66	0.018	0.71	1.75

Another way to analyze safety data is to look at when accidents occur. The latest available three-year data from January 1, 2007 through December 31, 2009 were analyzed and summarized. Note that these TASAS data do not rely on automatic detection systems.

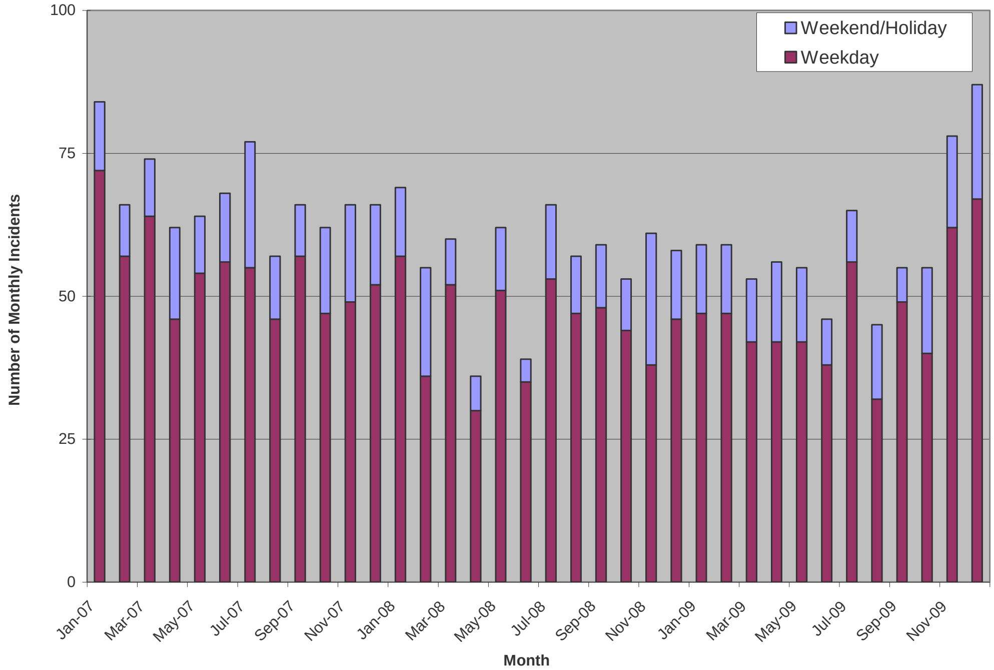
Exhibits 3-48 and 3-49 summarize the total number of weekday and weekend/holiday accidents by month in each direction. As shown in Exhibit 3-48, the number of northbound accidents decreased annually from 695 in 2007, to 653 in 2008, and 586 in 2009. In the southbound direction, accidents decreased from 812 in 2007 to 675 in 2008 but increased to 713 in 2009. The southbound direction outnumbered the northbound direction in the number of accidents during all three years. Similar to delay, when congestion increases, accidents increase.

Exhibit 3-48: Northbound Monthly Accidents (2007-2009)



Source: Caltrans TASAS

Exhibit 3-49: Southbound Monthly Accidents (2007-2009)



Source: Caltrans TASAS

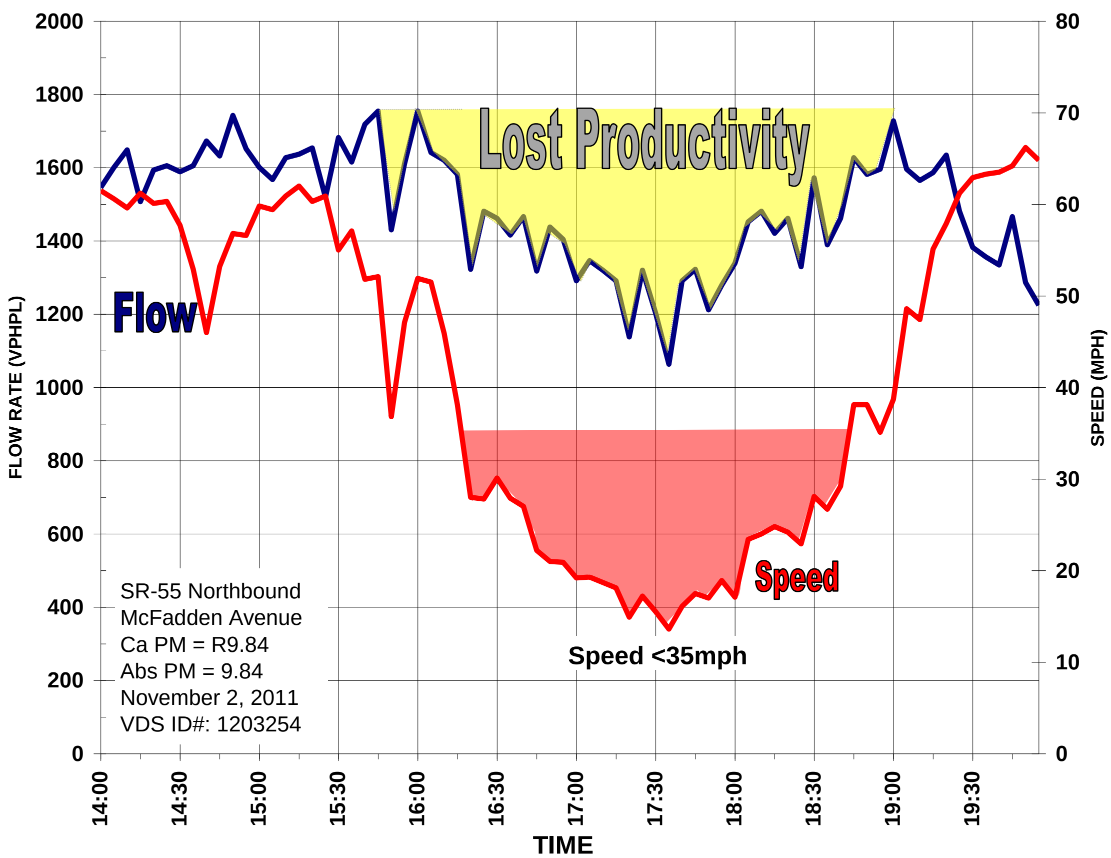
Productivity

Productivity is a system efficiency measure used to analyze the capacity of the corridor, and is defined as the ratio of output (or service) per unit of input. In the case of transportation, productivity is the percent utilization of a facility or mode under peak congested conditions.

For highways, it is the number of vehicles compared to the capacity of the roadways and the output is the number of people or vehicles that can pass through that roadway, and is calculated as the actual volume divided by the theoretical capacity of the highway. Highway productivity is particularly important because where capacity is needed the most, the lowest "production" from the transportation system often occurs.

This loss in productivity example is illustrated in Exhibit 3-50, which is the same lost productivity chart presented in Section 1 of this report. As traffic flow increases to the capacity limits of a roadway, speeds decline rapidly and throughput drops dramatically. This loss in throughput is the lost productivity of the system.

Exhibit 3-50: Lost Productivity Illustrated on SR-55 Corridor (2011)



Source: Caltrans detector data

There are a few ways to estimate productivity losses. Regardless of the approach, highway productivity calculations require good detection or significant field data collection at congested locations.

One approach is to convert this lost productivity into “equivalent lost lane-miles.” Equivalent lost lane-miles is computed as follows (for congested locations only):

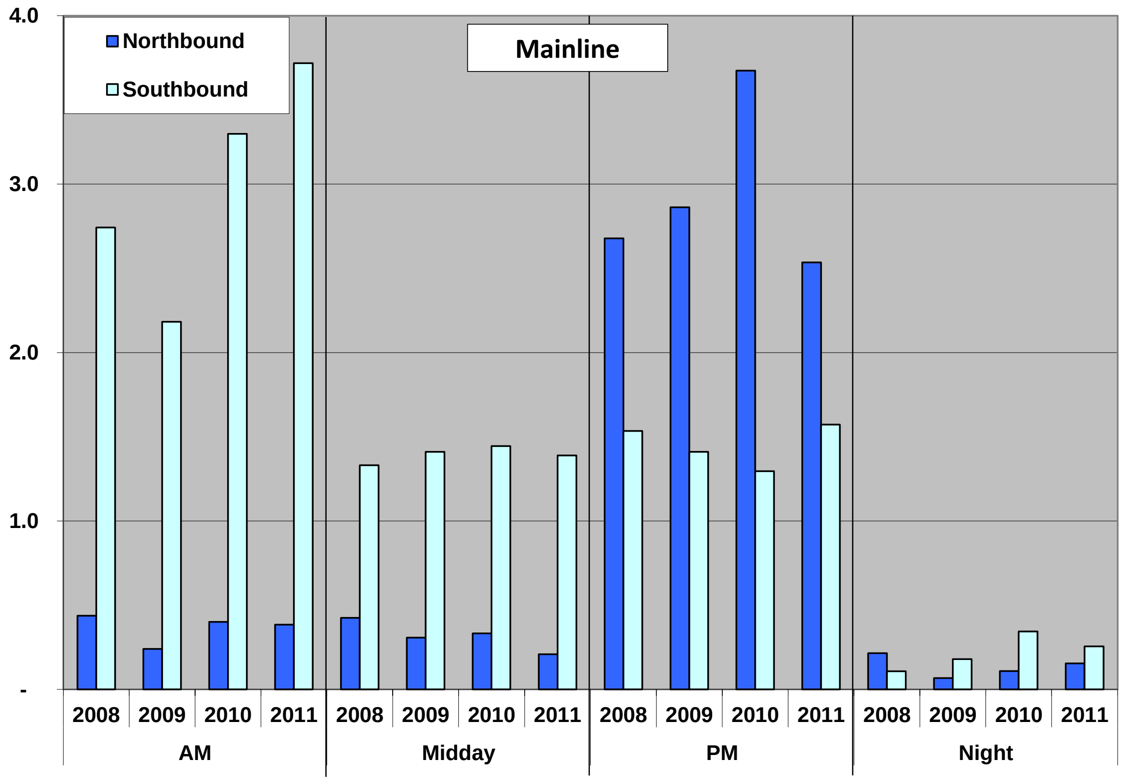
$$LostLaneMiles = \left(1 - \frac{ObservedLaneThroughput}{2000vphpl}\right) \times Lanes \times CongestedDistance$$

Strategies to combat such productivity losses are primarily related to operations. These strategies include: building new or extending auxiliary lanes, developing more aggressive ramp metering strategies without negatively influencing the arterial network, and improving incident clearance times.

Exhibit 3-51 summarizes the productivity losses on the mainline from 2008 to 2011. The largest productivity losses occurred during the PM peak hours in the northbound direction (as noted by the taller blue shaded bars), which is the time period and direction that experienced the most congestion or delay. During the PM peak in 2010, the northbound direction lost 3.7 equivalent lane-miles, which is an increase from the prior years. The southbound direction of the mainline (aqua shaded bars) also experienced productivity losses during the PM peak, but experienced the highest loss in productivity during the AM peak in 2011 of 3.7 equivalent lane-miles.

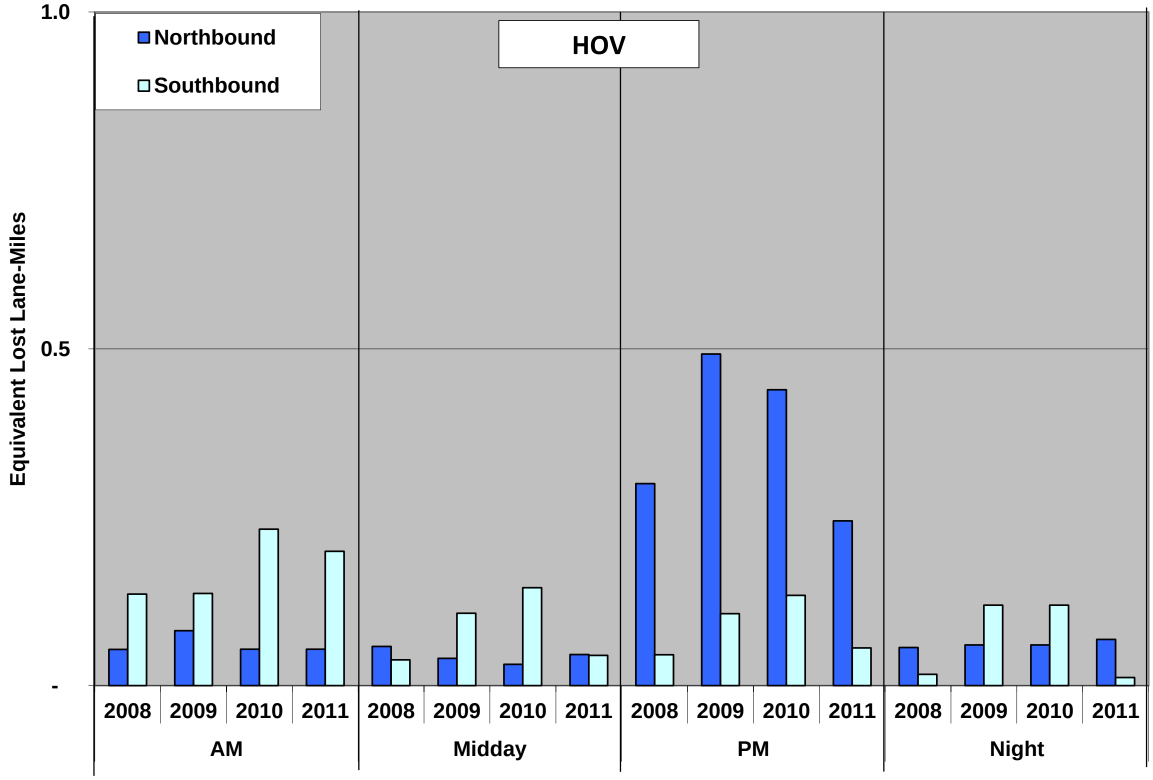
Exhibit 3-52 summarizes the productivity losses on the HOV facility during the same period. Again, the northbound direction shows the greatest productivity losses during the PM peak period. However, productivity losses were higher in 2009 with almost 0.5 equivalent lane-miles, compared the other three years. Productivity losses in the southbound direction was higher in 2010 than the other three years, but lower than productivity losses experienced in the northbound direction.

Exhibit 3-51: SR-55 ML Daily Equivalent Lost Lane-Mile by Direction and Period (2008-2011)



Source: Caltrans detector data

Exhibit 3-52: SR-55 HOV Daily Equivalent Lost Lane-Mile by Direction and Period (2008-2011)



Source: Caltrans detector data

Pavement Condition

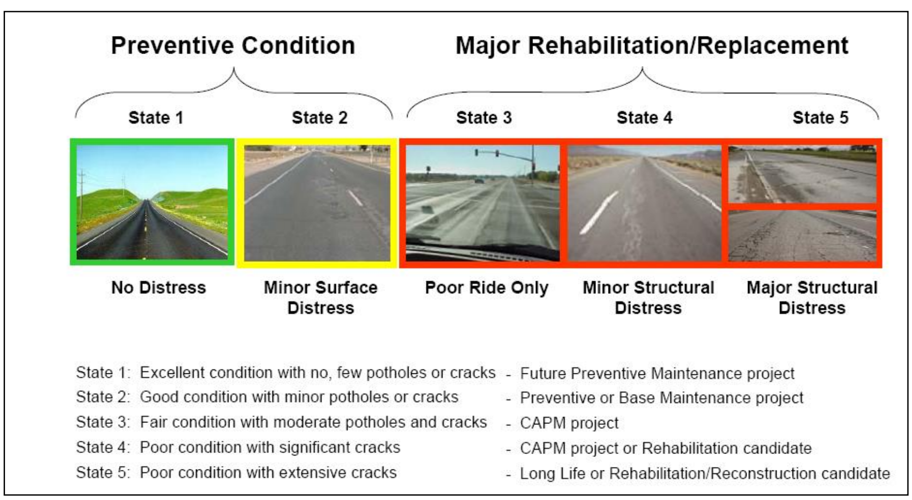
The condition of the roadway pavement (or ride quality) on the corridor can influence its traffic performance. Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor, whereas smooth pavement can have the opposite effect. Pavement preservation refers to maintaining the structural adequacy and ride quality of the pavement. It is possible for a roadway section to have structural distress without affecting ride quality. Likewise, a roadway section may exhibit poor ride quality, while the pavement remains structurally adequate.

Pavement Performance Measures

Caltrans conducts an annual Pavement Condition Survey (PCS) that can be used to compute two performance measures commonly estimated by Caltrans: distressed lane-miles and International Roughness Index (IRI). Although Caltrans generally uses only distressed lane-miles for external reporting, this report presents results for both measures using the Caltrans data.

Distressed lane-miles help to distinguish between pavement segments that require only preventive or corrective maintenance at relatively low costs and segments that require major rehabilitation/replacement at significantly higher costs. All segments that require major rehabilitation/replacement are considered to be distressed. Segments with poor ride quality are also considered to be distressed. Exhibit 3-53 provides an illustration of this distinction. The first two pavement conditions include roadways that provide adequate ride quality and are structurally adequate. The remaining three conditions are included in the calculation of distressed lane-miles.

Exhibit 3-53: Pavement Condition States Illustrated



Source: Caltrans Division of Maintenance, 2007 State of the Pavement Report

IRI distinguishes between smooth-riding and rough-riding pavement. The distinction is based on measuring the up and down movement of a vehicle over pavement. When such movement is measured at 95 inches per mile or less, the pavement is considered good or smooth-riding. When movements are between 95 and 170 inches per mile, the pavement is considered acceptable. Measurements above 170 inches per mile reflect unacceptable or rough-riding conditions.

Existing Pavement Conditions

The most recent pavement condition survey, completed in June 2011, identified 12,333 distressed lane-miles statewide. The 2011 PCS began in July 2009 and was completed in June 2011. In the past, the Caltrans conducted the PCS once a year to measure changes in pavement condition. In 2008, data collection was changed to provide pavement performance for the future Pavement Management System (PMS). Similarly, the 2007 PCS included a transitional methodology that covered a 23-month period from January 2006 to November 2007.

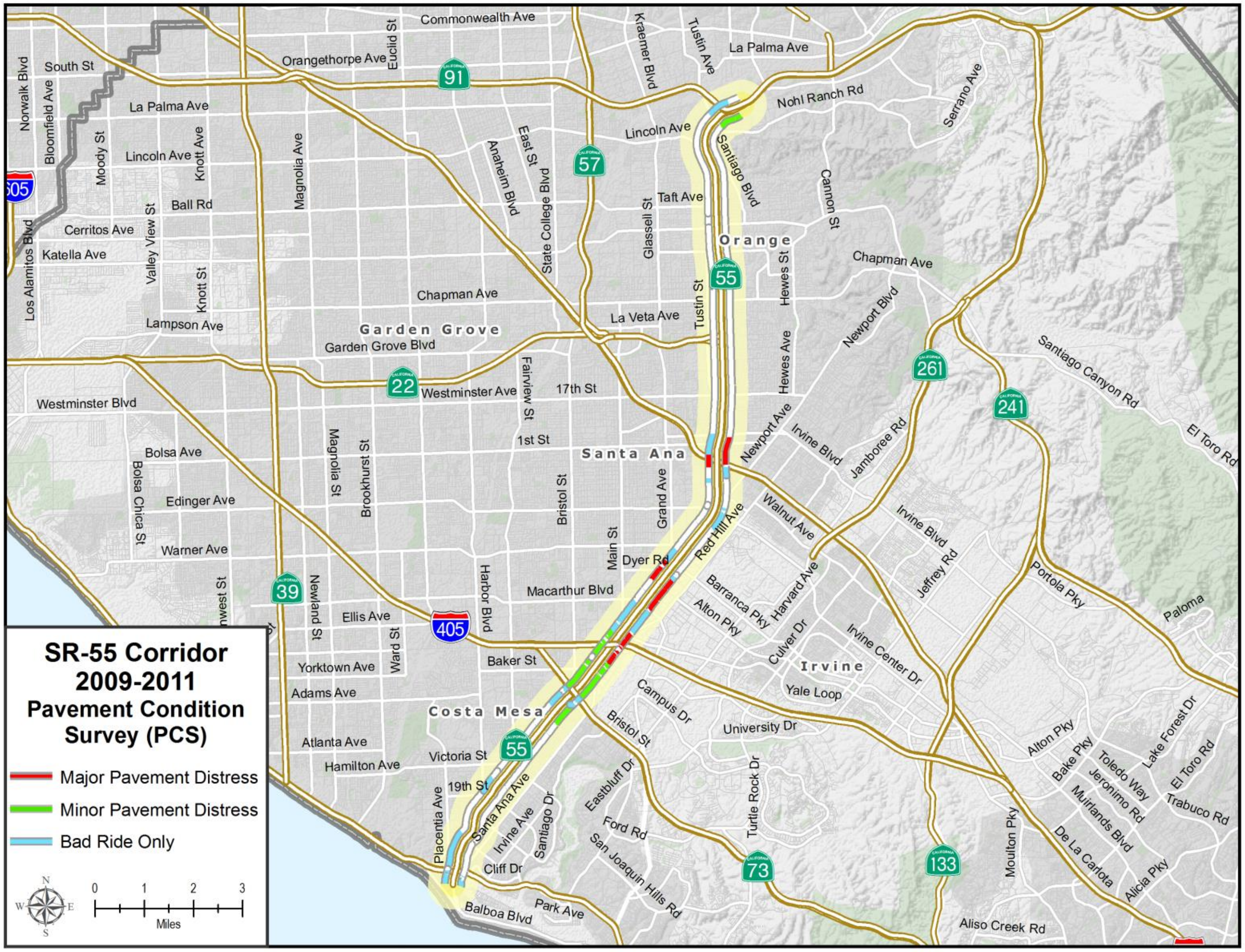
The field work consists of two parts. In the first part, pavement raters visually inspect the pavement surface to assess structural adequacy. In the second part, field staff uses vans with automated profilers to measure ride quality. The 2011 PCS revealed that the largest portion of distressed pavement (4,858 out of 12,333 distressed lane-miles) is on freeways and expressways (Class 1 roads), but the proportion has dropped. While approximately 52 percent of the State Highway System is Class 1, only 39 percent of the distressed lane-miles occur on these roads. As a percentage of total lane-miles by class, collectors and local roads (Class 3 roads) had the highest amount of distress.

Exhibit 3-54 shows pavement distress along the SR-55 Corridor according to the 2011 PCS data. The three categories shown in this exhibit represent the three distressed conditions that require major rehabilitation or replacement (shown in Exhibit 3-55).

The SR-55 Corridor has pavement distress comparable to a typical freeway in District 12. Very little of the corridor has any lanes exhibiting major pavement distress. Exhibit 3-55 shows results from prior pavement condition surveys along the study corridor. The number of distressed lane-miles increased dramatically from 2003 to 2004. While major pavement distress increased in 2005, it decreased slightly in 2006-2007 with 2006-2007 experiencing more increase in ride quality only issues. In 2008, pavement distress decreased dramatically with some increase in ride quality issues. However, from 2009 to 2011, pavement distress increased dramatically while also experiencing a slight increase in ride quality.

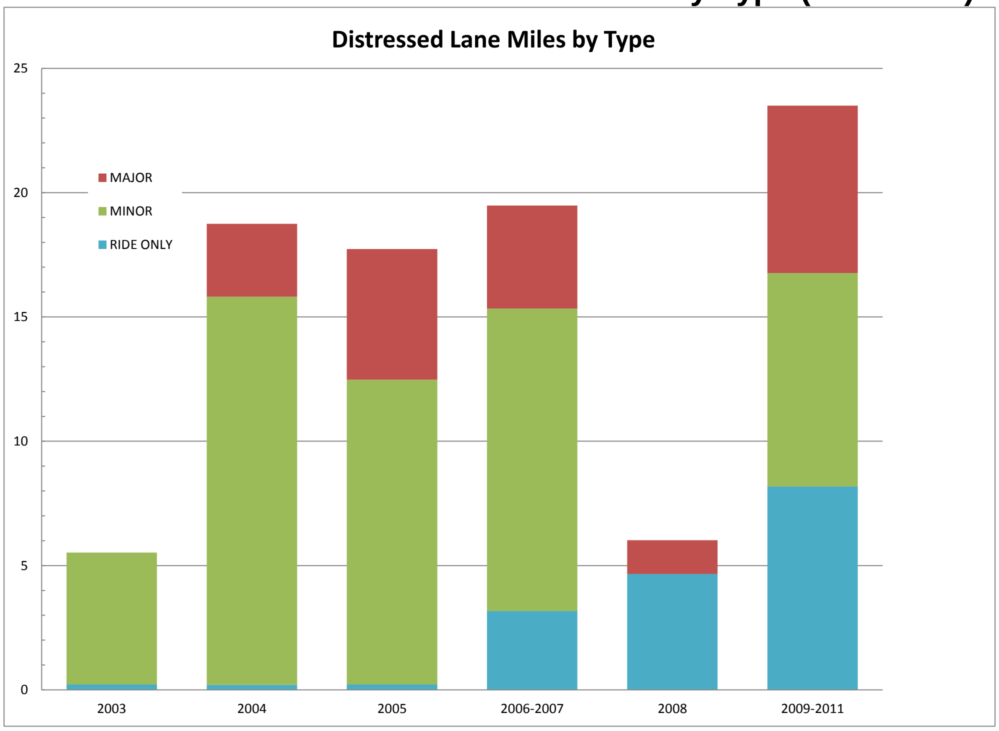
This change in the mix of distressed lane-miles is shown more clearly in Exhibit 3-58. While major pavement distress stayed similar from 2006 through 2008, from 2009 to 2011, both major and minor pavement distress also increased.

Exhibit 3-54: Distressed Lane-Miles on SR-55 Corridor (2009-2011)



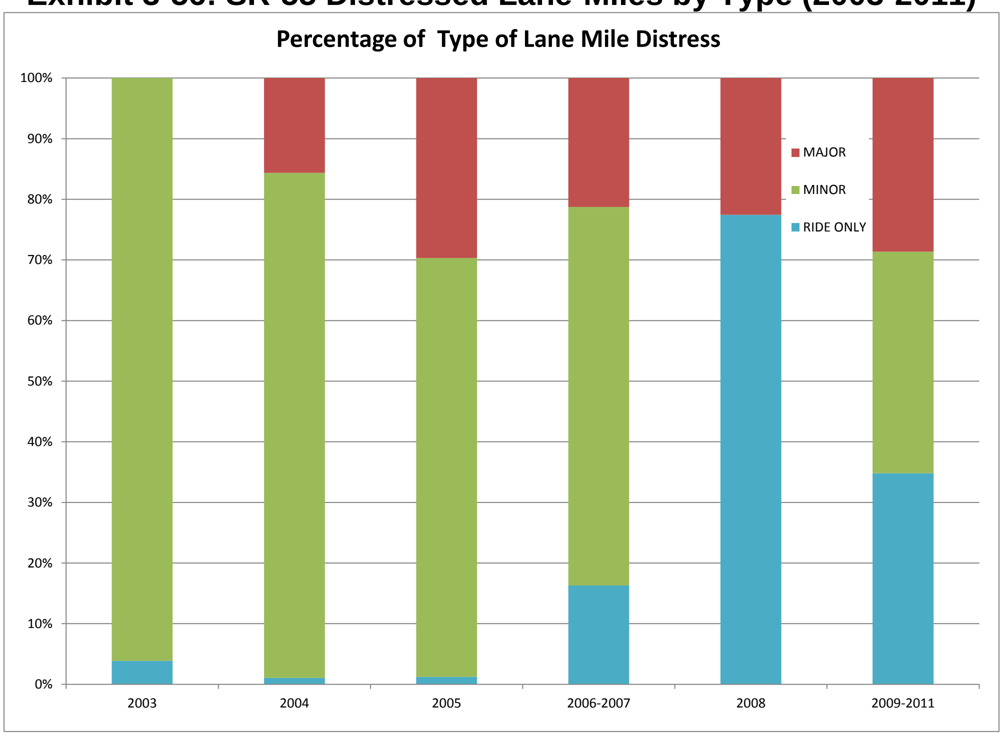
Source: Pavement Condition Survey data

Exhibit 3-55: SR-55 Distressed Lane-Miles by Type (2003-2011)



Source: Pavement Condition Survey data

Exhibit 3-56: SR-55 Distressed Lane-Miles by Type (2003-2011)



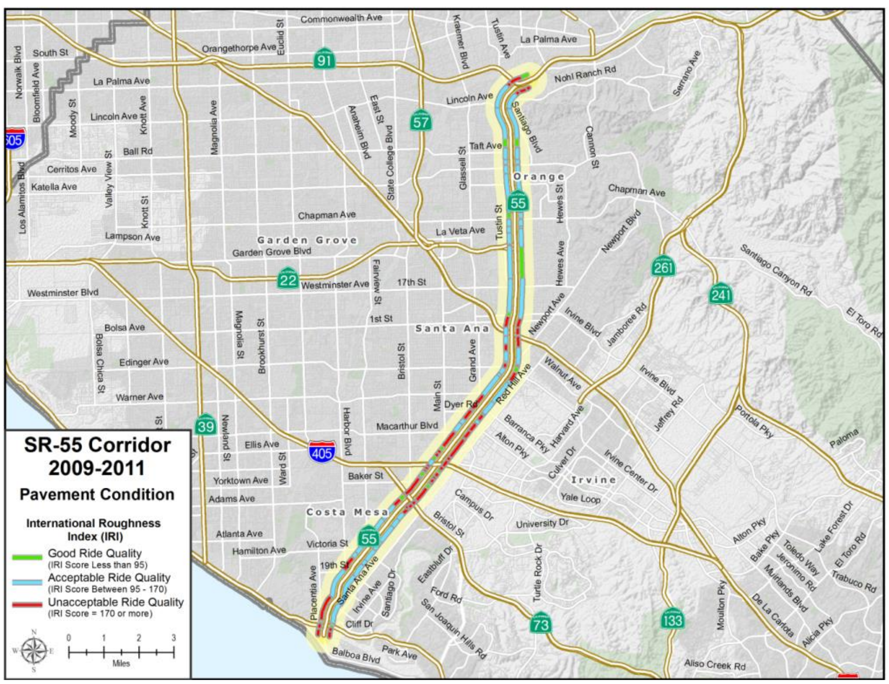
Source: Pavement Condition Survey data

Exhibit 3-57 shows IRI along the study corridor for the lane with the poorest pavement condition in each freeway segment. The poorest pavement conditions are shown in the exhibit because pavement investment decisions are made on this basis. As the exhibit shows, over 80 percent of the corridor has good or acceptable ride quality (IRI less than 170), while the rest of the corridor has ride quality issues (IRI greater than 170). Not all of these sections appear in Exhibit 3-57 due to algorithms and thresholds in the PCS.

When the conditions on all lanes are considered, the study corridor comprises roughly 150 lane-miles, of which:

- 24 lane-miles, or 15 percent, are considered to have good ride quality (IRI ≤ 95)
- 104 lane-miles, or 66 percent, are considered to have acceptable ride quality (95 < IRI ≤ 170)
- 22 lane-miles, or 14 percent, are considered to have unacceptable ride quality (IRI > 170)

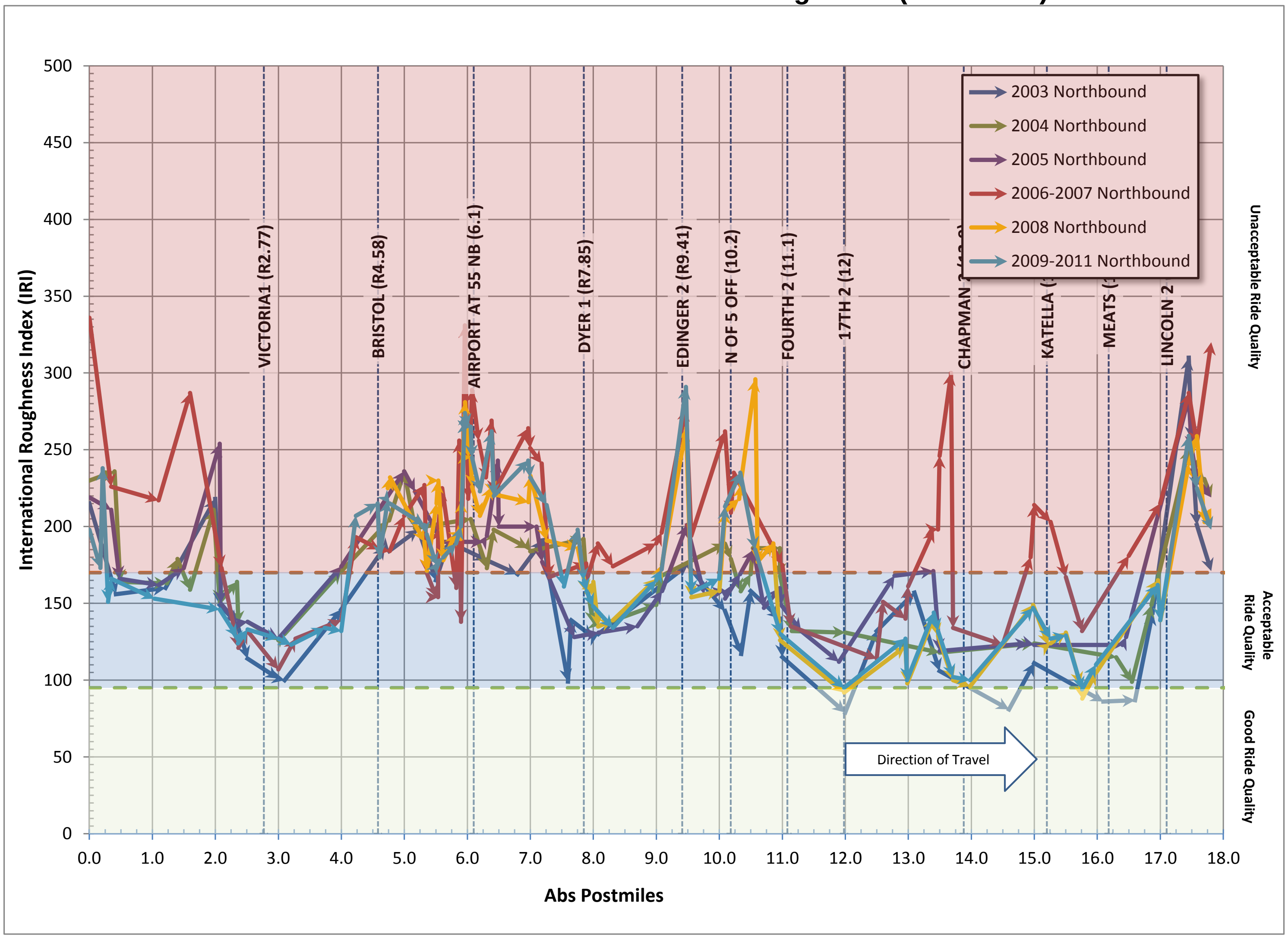
Exhibit 3-57: SR-55 Road Roughness (2009-2011)



Source: Pavement Condition Survey data

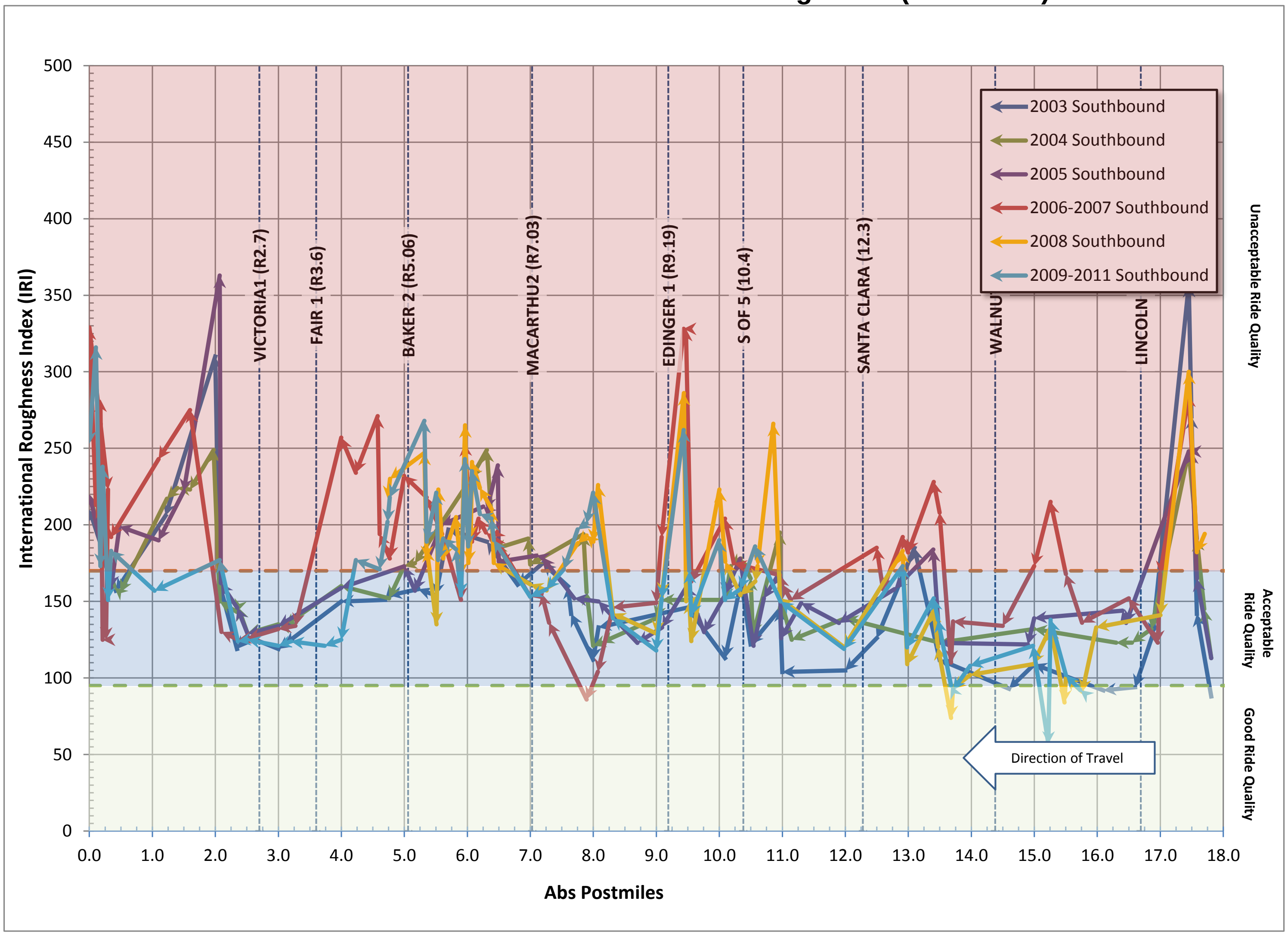
Exhibits 3-58 and 3-59 present ride conditions for the SR-55 corridor using IRI from the last four pavement surveys. The information is presented by Post Mile and direction. The exhibits include color-coded bands to indicate the three ride quality categories defined by Caltrans: good ride quality (green), acceptable ride quality (blue), and unacceptable ride quality (red). The surveys show consistent patterns of good, acceptable, and unacceptable ride quality. Ride quality has worsened slightly over the last few surveys, but this is expected with the aging of the freeway.

Exhibit 3-58: Northbound SR-55 Road Roughness (2003-2011)



Source: Pavement Condition Survey data

Exhibit 3-59: Southbound SR-55 Road Roughness (2003-2011)



Source: Pavement Condition Survey data

4. BOTTLENECK IDENTIFICATION AND PERFORMANCE

Major bottlenecks are the primary cause of congestion and lost productivity. A bottleneck is a location where traffic demand exceeds the effective carrying capacity of the roadway. In most cases, a bottleneck is caused by a sudden reduction in effective capacity, such as a physical loss in capacity when a lane drop occurs or when heavy merging and weaving take place near on and off-ramps. On the demand side, surges in demand, often from on-ramps, can be greater than a roadway can accommodate when the road is approaching its maximum capacity.

Bottlenecks on the SR-55 corridor were identified and verified based on a variety of data sources, including Caltrans detector data, Caltrans probe vehicle run data, and extensive consultant team field observations and video-taping. Some of the field observations were conducted collaboratively with Caltrans District 12 staff to verify bottlenecks and their causes. These efforts resulted in confirming sets of bottlenecks for both directions of the freeway.

Exhibit 4-1 is a table that summarizes the bottleneck locations identified in this analysis. Major controlling and minor bottlenecks were identified (minor bottlenecks include hidden bottlenecks that are overtaken by queuing from a downstream bottleneck or by reduced traffic flow from an upstream bottleneck). Although they are hidden bottlenecks, some of them can be major in terms of congestion and delay impacts.

Exhibit 4-1: SR-55 Bottleneck Locations

Northbound

No.	Major Bottleneck Location	Hidden Bottleneck Location	Active Period		From		To (At)		Distance (miles)
			AM	PM	Abs	CA	Abs	CA	
N1	NB Off to SB-405		✓		2.2	R2.2	5.7	R5.7	3.5
N2	Paularino C/D On		☑	✓	5.7	R5.7	6.0	R6.0	0.3
N3A		NB On from NB-405	☑	✓			6.5	R6.5	
N3	MacArthur On			✓	6.0	R6.0	7.2	R7.2	1.2
N4	Dyer On			✓	7.2	R7.2	8.1	R8.1	0.9
N5	NB-5 Off		☑	✓	8.1	R8.1	10.0	10.0	1.9
N6B		NB On from NB-5		✓			10.8	10.8	
N6A		17th Street Off		✓			11.5	11.5	
N6	17th Street On			✓	10.0	10.0	12.0	12.0	2.0
N7A		SR22 Off		✓			12.8	12.8	
N8A		Chapman Off		✓			13.8	13.8	
N9A		Lincoln Off		✓			17.0	17.0	
	None				12.0	12.0	17.9	17.9	5.9
									15.7

Southbound

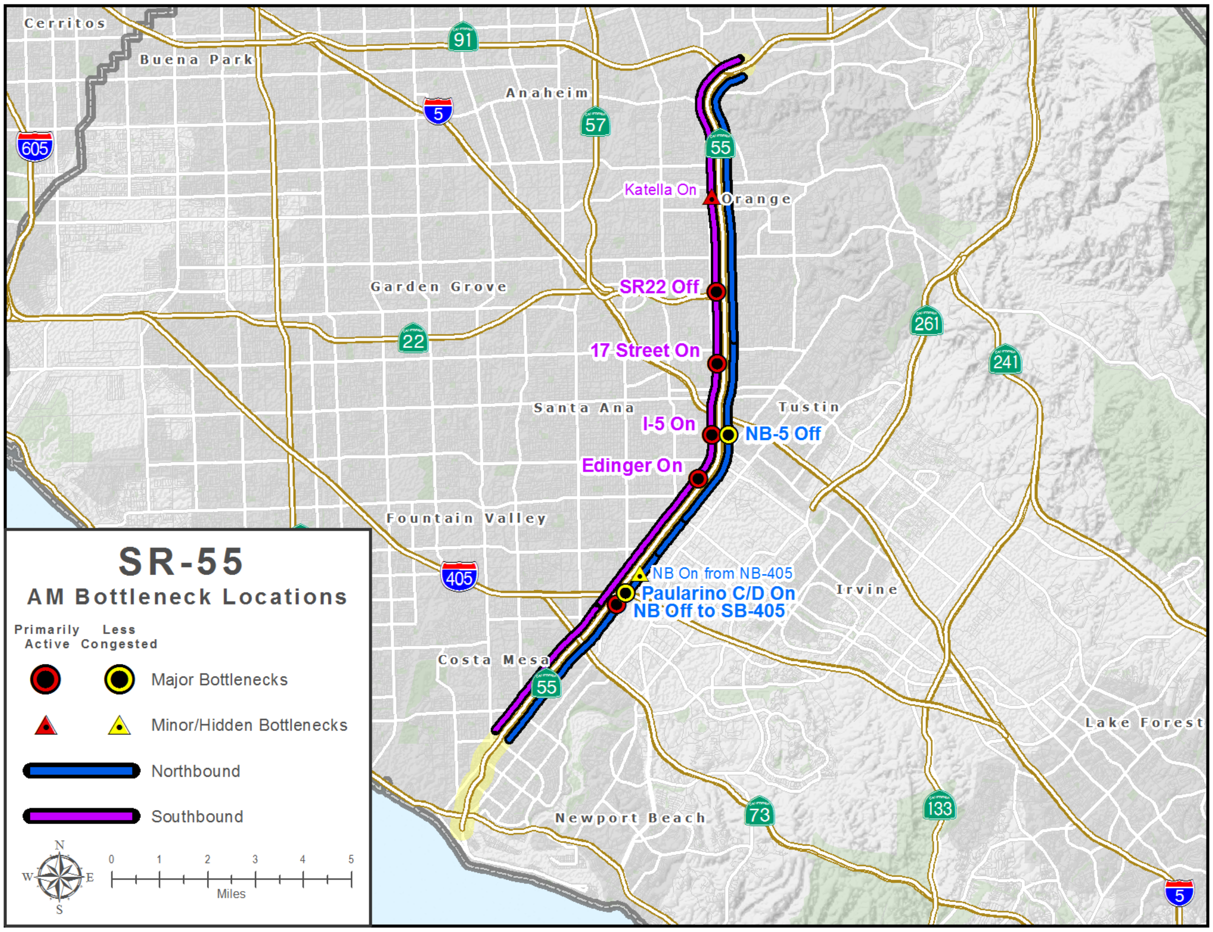
No.	Major Bottleneck Location	Hidden Bottleneck Location	Active Period		From		To (At)		Distance (miles)
			AM	PM	Abs	CA	Abs	CA	
S1A		Katella On	✓				15.0	15.0	
S1	SR22 Off		✓	☑	17.9	17.9	13.0	13.0	4.9
S2	17 Street On		✓	☑	13.0	13.0	11.5	11.5	1.5
S3	I-5 On		✓	☑	11.5	11.5	10.0	10.0	1.5
S4	Edinger On		✓	✓	10.0	10.0	9.0	R9.0	1.0
S5	Baker Off			✓	9.0	R9.0	5.5	R5.5	3.5
S6A		19th St I/S (active during summer middays)					2.0	R2.0	
	None				5.5	R5.5	2.2	R2.2	3.3
									15.7

NOTES:

Hidden bottlenecks are bottlenecks hidden by queuing from downstream bottleneck or demand held by upstream bottleneck(s).

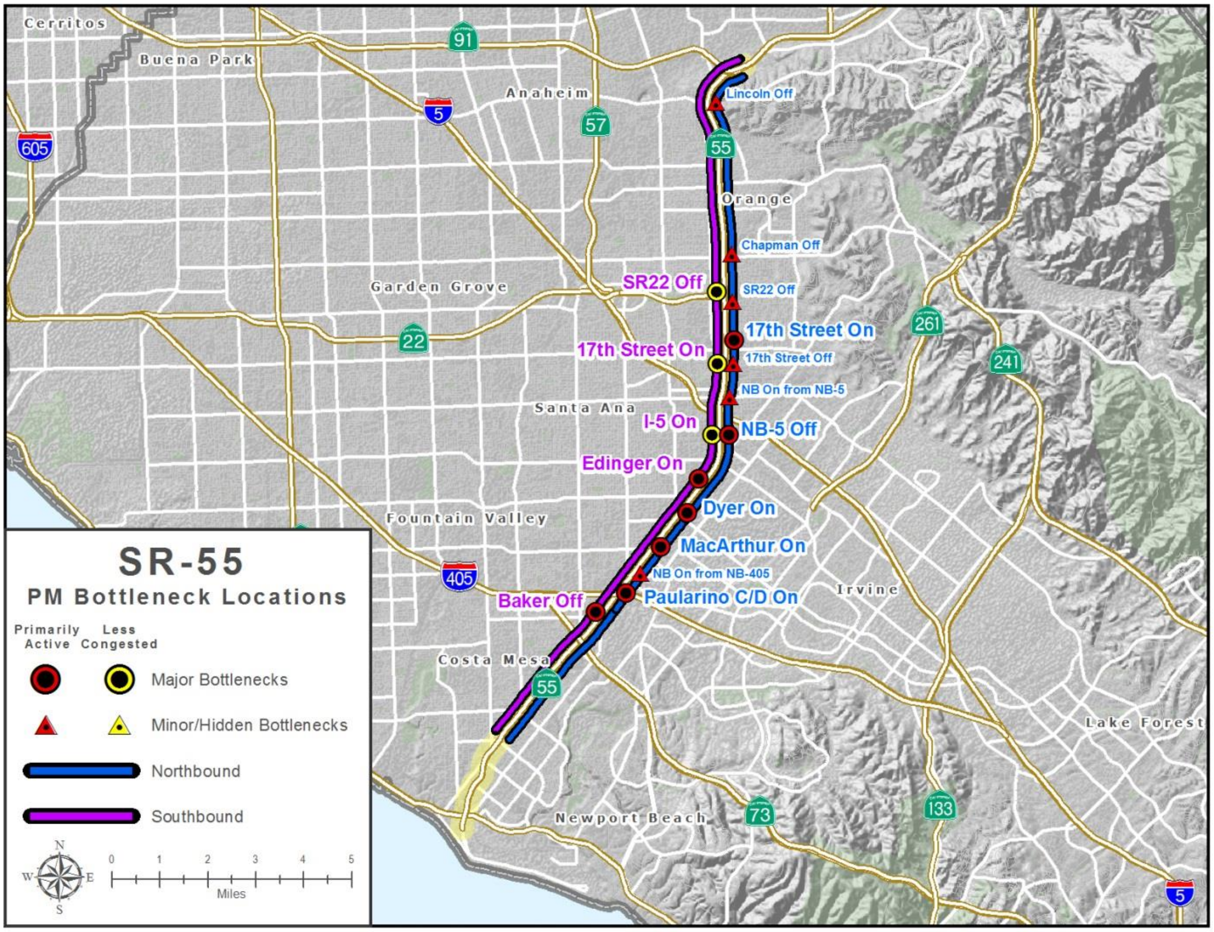
- ✓ Primarily active during this peak period
- ☑ Less congested bottleneck but also occurs during this peak period

Exhibit 4-2: Map of AM Bottlenecks



Source: System Metrics Group, Inc. analysis

Exhibit 4-3: Map of PM Bottlenecks



Source: System Metrics Group, Inc. analysis

Bottleneck Identification

Caltrans detector data from the Performance Measurement System (PeMS) and probe vehicle runs using GPS technology were two main sources used to identify potential bottlenecks prior to conducting field visits. Analyses were performed for both the mainline facility and the HOV lane.

There are two types of PeMS plots used for this analysis. The first type, a “speed contour” plot, shows speeds for every detector location at five-minute intervals throughout the day. The resulting plot shows the location, extent, and duration of congestion. The second, a “speed profile” plot, shows the speeds along the corridor for every detector location for a single 5-minute interval on a given day. Speed profile plots are similar to probe vehicle run plots that show the speeds along the corridor at various increments for the run starting at selected time of day.

Northbound SR-55 Mainline Facility

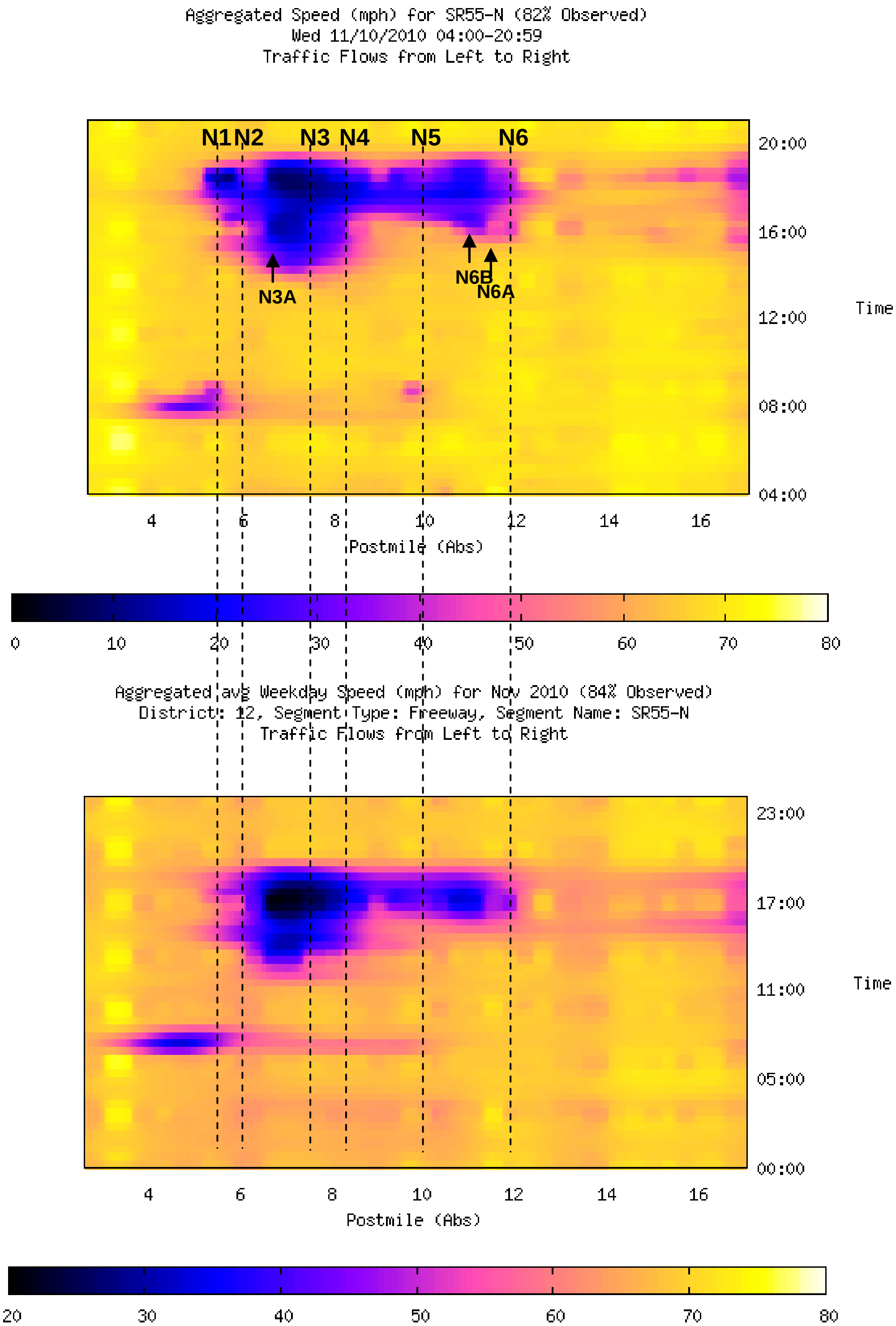
Speed contour and profile plots were analyzed for different midweek days in November 2010 and November 2011. Aggregate average speed contours of weekdays in November 2010 and November 2011 were also examined.

Exhibit 4-4 shows the speed contour plot for Wednesday November 10, 2010 along with the weekday average speed plot for the entire month of November 2010 for the northbound direction (traffic moving from left to right on the x-axis of the plots). The vertical or y-axis is the time of day between 4:00 AM and 8:00 PM. The horizontal axis or x-axis is the corridor segment from 19th Street in Costa Mesa, post mile 2.0, to SR-91 at post mile 17.9.

The dark blue spots indicate slow speeds and congestion. The vertical dotted lines identify the actual bottleneck location labeled with a bottleneck number as listed in the table in Exhibit 4-1. There are six major bottleneck locations (labeled N1 to N6) and six hidden bottlenecks in the northbound direction. A hidden bottleneck is one that is overwhelmed by a larger downstream bottleneck, but would be revealed should the downstream bottleneck disappear.

The most significant major bottleneck occurs at the Dyer interchange (N4) primarily during the PM peak period. The congested queues extend upstream past the I-405 interchange, a distance of over three miles. The congested time period lasts over five hours, from approximately 2:00 PM to 7:00 PM.

Exhibit 4-4: Northbound SR-55 Speed Contour Plots (November 2010)

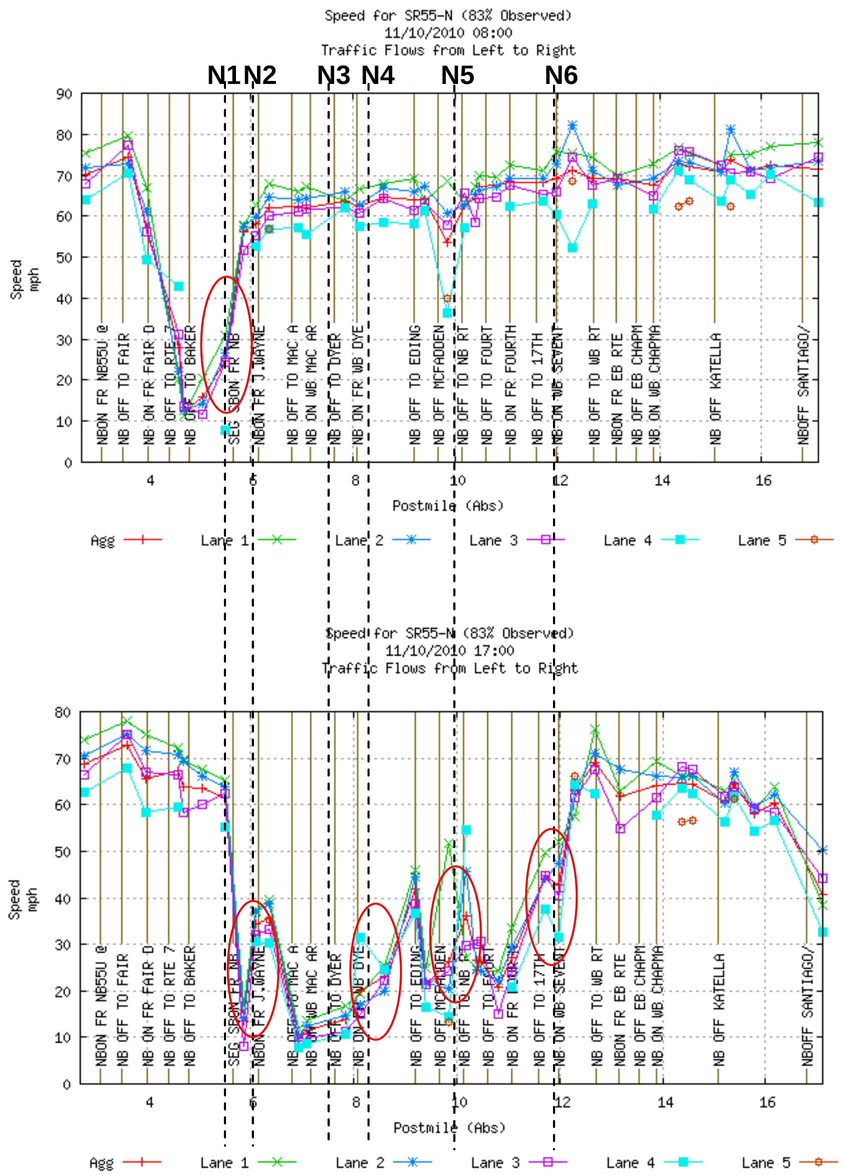


Source: Caltrans Performance Measurement System (PeMS) data

Exhibit 4-5 shows the speed profile plots from PeMS. The top figure is the profile plot at 8:00 AM and the bottom figure is the profile plot at 5:00 PM on November 10, 2010.

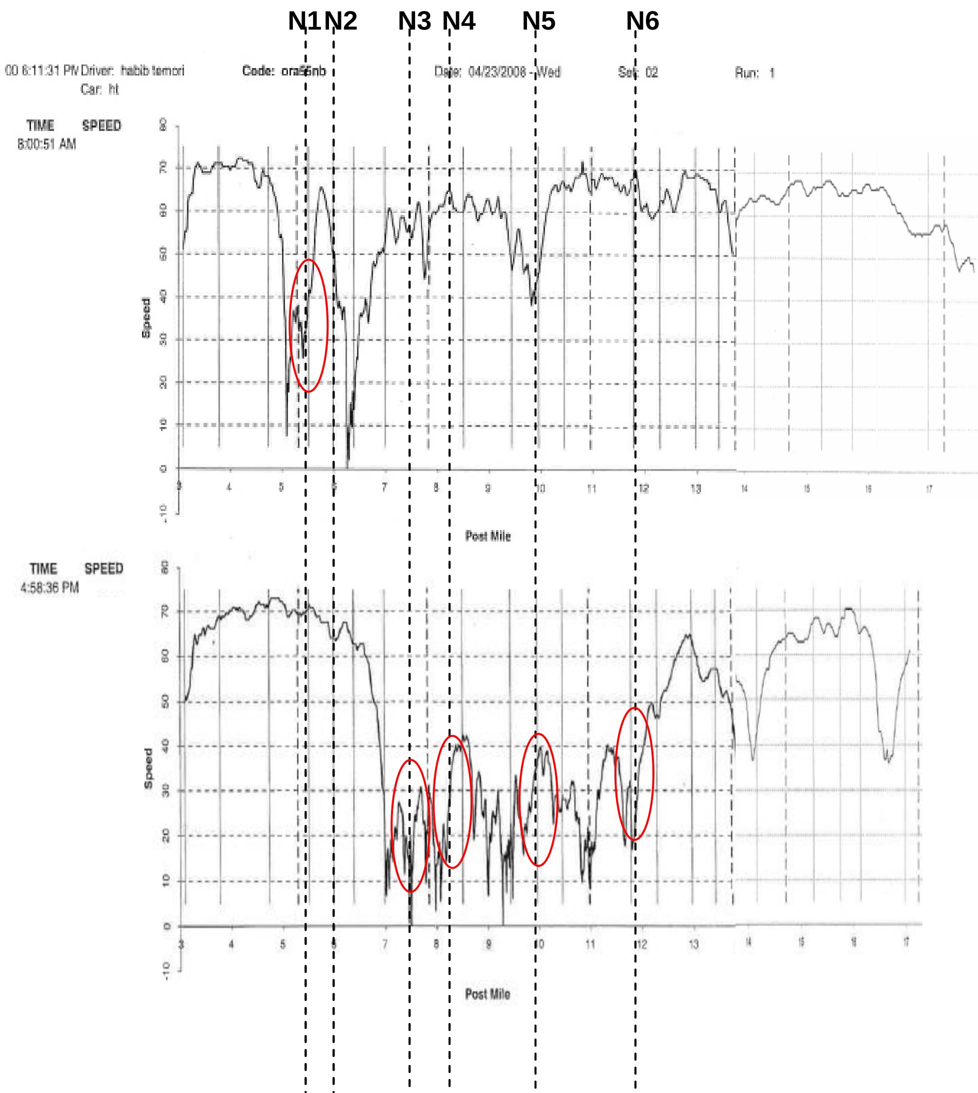
Exhibit 4-6 shows speed profile plots from Caltrans probe vehicle runs conducted on April 28, 2008 using GPS technology. The top figure in Exhibit 4-6 is a run starting at 8:00 AM and the bottom figure is a run that started at 4:58 PM. The plots confirm the same major bottleneck locations identified in Exhibit 4-4. These plots do not show all of the major and hidden bottleneck locations as they represent only one time slice in the AM peak and one in the PM peak.

Exhibit 4-5: Northbound SR-55 Speed Profile Plots (November 2010)



Source: Caltrans Performance Measurement System (PeMS) data

Exhibit 4-6: Northbound SR-55 Speed Profile Plots (April 2008)



Southbound SR-55 Mainline Facility

Speed contour and profile plots were also analyzed for different midweek days in November 2010 and November 2011 for the southbound direction. Aggregate average speed contours for weekdays in November 2010 and November 2011 were also examined.

Exhibit 4-7 shows the speed contour plots for a sample midweek day in November 2010 and an aggregate average of November 2010 weekdays used to analyze the southbound direction (traffic moving left to right on the plot). The vertical or y-axis is the time of day from 4:00 AM to 8:00 PM. The horizontal axis or x-axis is the corridor segment from SR-91, post mile 17.9, to 19th Street, located at post mile 2.2.

Again, the dark blue blotches indicate slow speeds and congestion. The vertical dotted lines show the verified bottleneck location, which is labeled with a bottleneck number as listed in Exhibit 4-1. Exhibit 4-7 identifies five major bottleneck locations (labeled S1 to S5) and one hidden bottleneck.

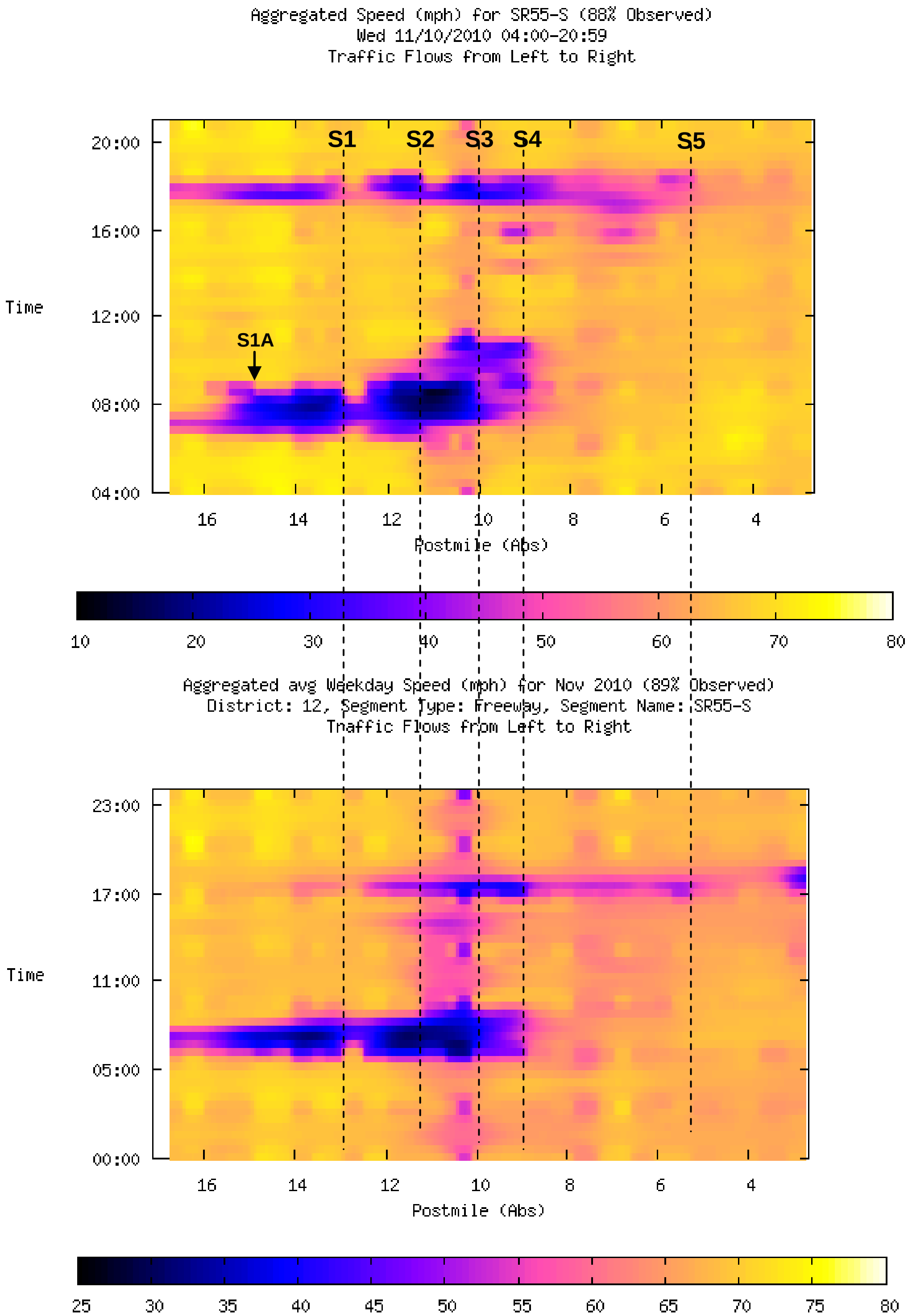
The most significant major bottleneck in the southbound direction occurs at the I-5 interchange and is primarily active during the AM peak period. The congested queues extend as far upstream as SR-91, a distance of nearly eight miles, with the congested period lasting over two hours, from 7:00 AM to 9:00 AM.

Exhibit 4-8 are the speed profile plots downloaded from PeMS. The top figure is the profile plot at 8:00 AM and the bottom figure is the profile plot at 5:30 PM on November 10, 2010. Exhibit 4-9 shows the speed profile plots from Caltrans probe vehicle runs conducted on April 23, 2008 using GPS technology. The top figure represents the run starting at 7:58 AM and the bottom figure is the run starting at 5:23 PM. The plots confirm the same major bottleneck locations identified in Exhibit 4-7. These plots do not show all of the major and hidden bottleneck locations as they represent only one time slice in the AM peak and one in the PM peak.

Extensive detector data analysis of other days, including more recent years, indicate the same bottlenecks for both northbound and southbound directions. The study team also conducted numerous field visits in November and December 2011 to observe corridor conditions. Potential bottleneck locations identified from the data analysis were verified by both driving along the freeway during congested times of the day and by observing the traffic from vantage points such as overcrossings.

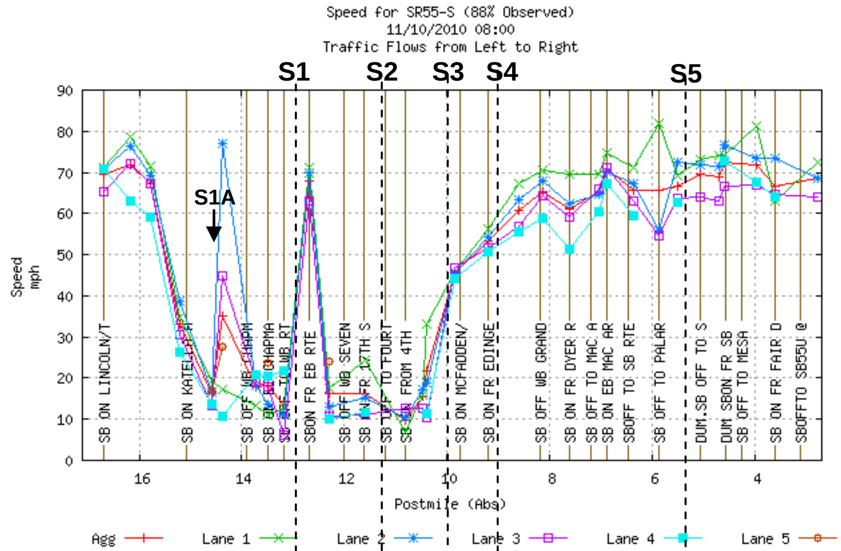
Most of the bottlenecks that were videotaped were reviewed to confirm the bottleneck locations and to identify their causes. Additional field visits were conducted in January 2012 by the study team along with Caltrans District 12 staff with extensive knowledge and experience of the SR-55 corridor to review and confirm the bottleneck locations identified.

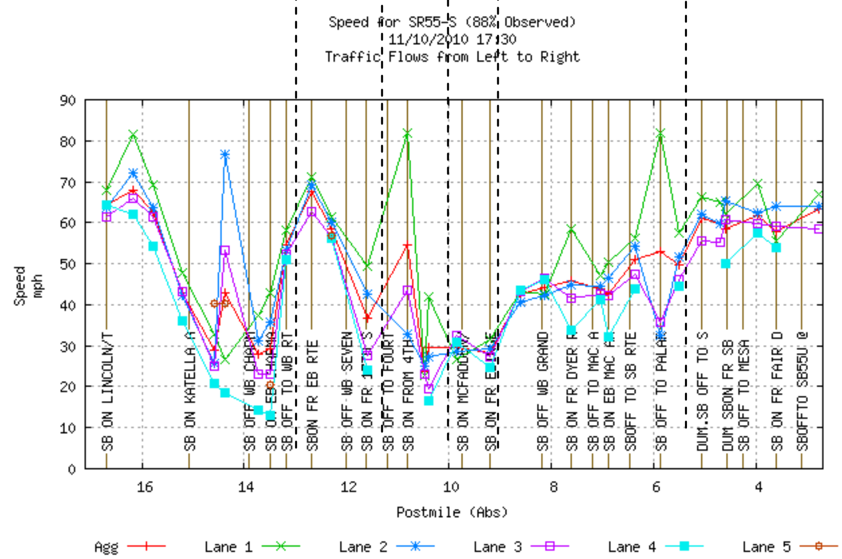
Exhibit 4-7: Southbound SR-55 Speed Contour Plots (November 2010)



Source: Caltrans Performance Measurement System (PeMS) data

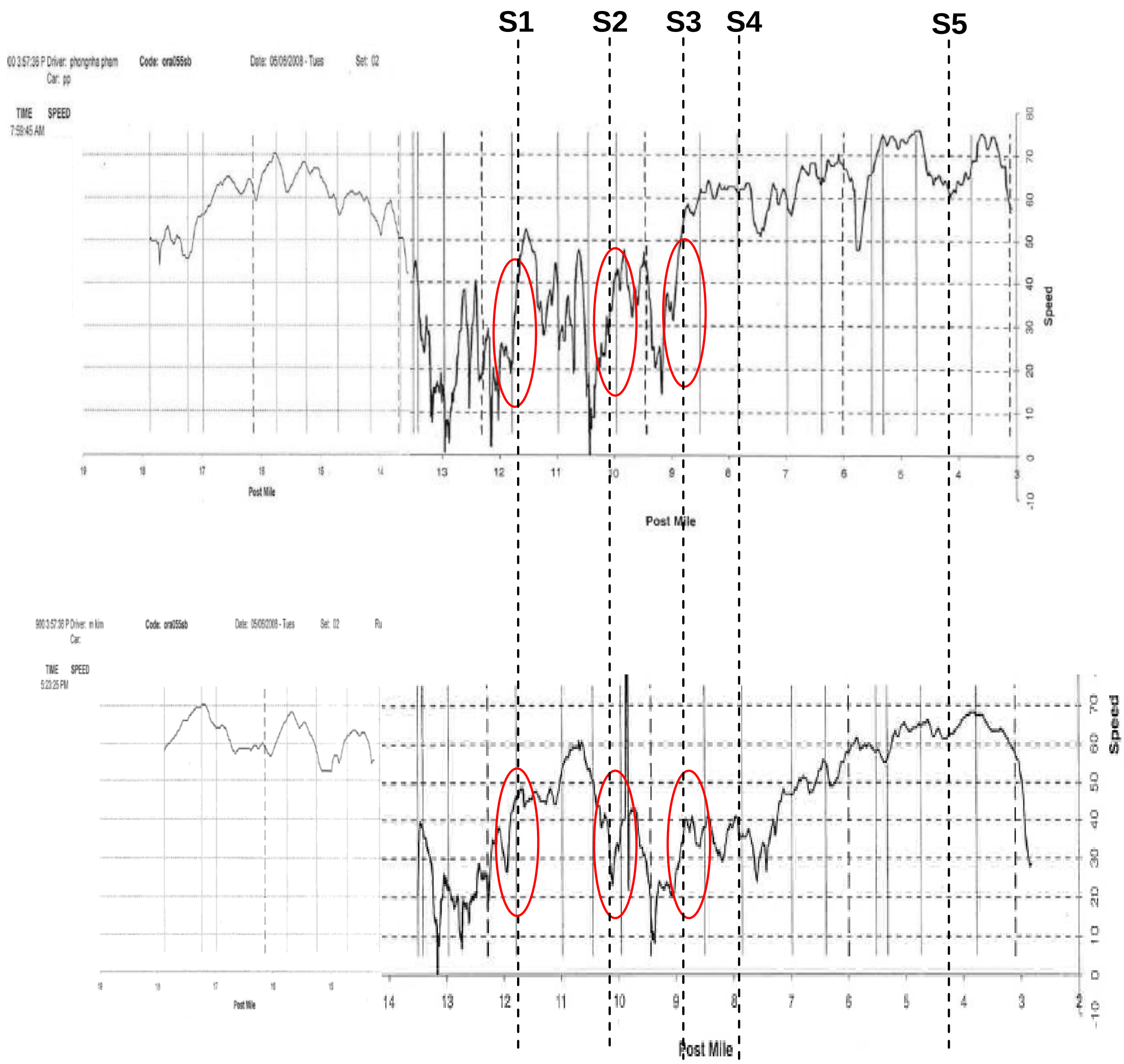
Exhibit 4-8: Southbound SR-55 Speed Profile Plots (November 2010)





Source: Caltrans Performance Measurement System (PeMS) data

Exhibit 4-9: Southbound SR-55 Speed Profile Plots (April 2008)



SR-55 High Occupancy Vehicle (HOV) Facility

Bottlenecks were also identified and verified for both directions of the HOV lane using Caltrans detector data, field observations, and video-taping.

The resulting plot shows the location, extent, and duration of congestion. PeMS speed profile plots provide speeds across the corridor at a particular time of day. Bottlenecks are located at the downstream end of a congested segment where speeds are very low (e.g., less than 35 mph). The downstream location where speeds increase significantly from being very congested is the bottleneck location. Exhibit 4-10 summarizes the bottleneck locations identified on the HOV facility.

Exhibit 4-10: Orange County SR-55 HOV Lanes Bottleneck Locations

Northbound

No.	Major Bottleneck Location	Active Period		To (At)	
		AM	PM	Abs	CA
HOVN1	Dyer On		✓	8.1	R8.1
HOVN2	NB-5 Off		✓	10.0	10.0
HOVN3	17th Street On		✓	12.0	12.0

Southbound

No.	Major Bottleneck Location	Active Period		To (At)	
		AM	PM	Abs	CA
HOVS1	Chapman Off	✓	☑	13.5	13.5
HOVS2	17 Street Off	✓	☑	12.0	12.0
HOVS3	Edinger	✓	☑	9.0	R9.0

NOTES:
Hidden bottlenecks are bottlenecks hidden by queuing from downstream bottleneck or demand held by upstream bottleneck(s).

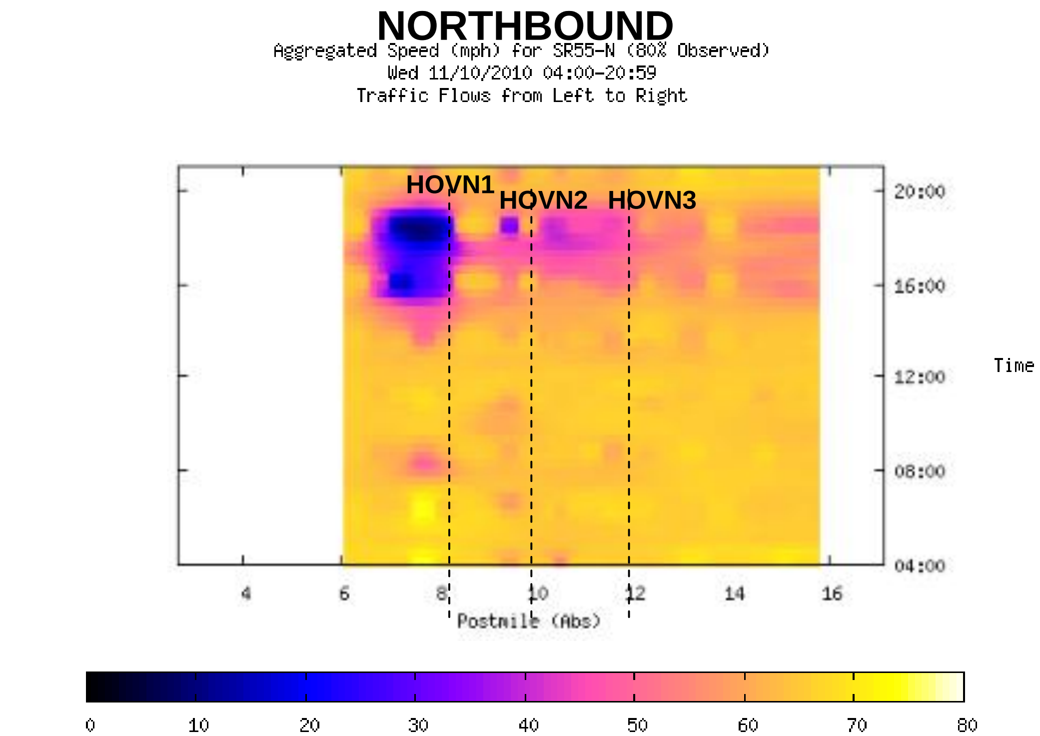
✓ Primarily active during this peak period
☑ Less congested bottleneck but also occurs during this peak period

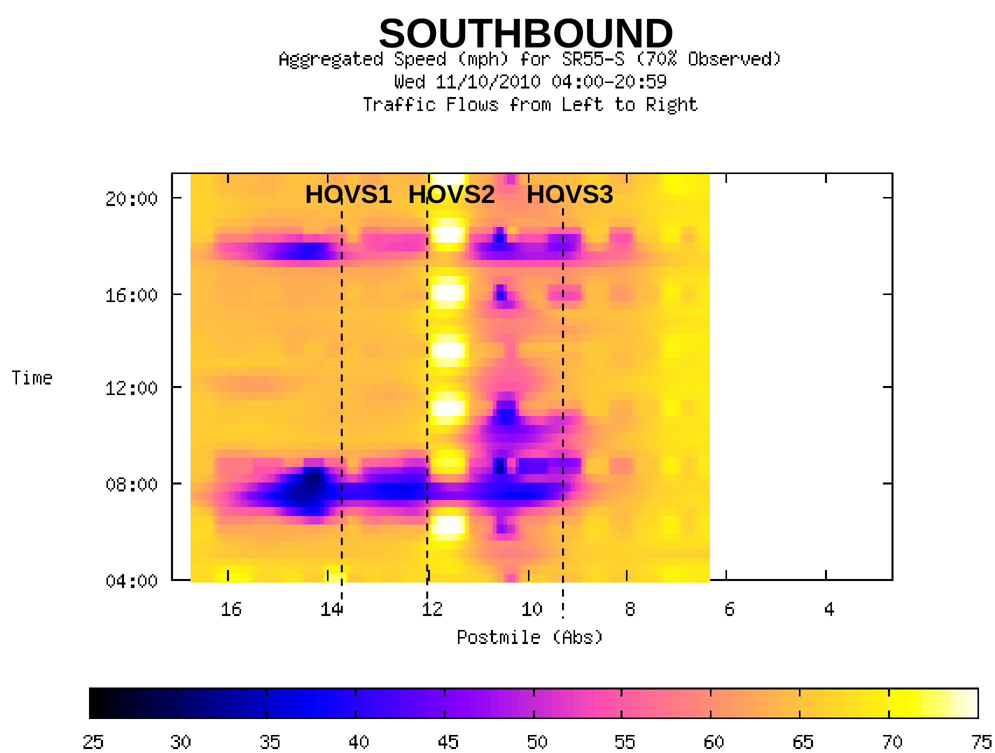
Exhibit 4-11 shows the HOV lane speed contour plots for Wednesday November 10, 2011. The first plot is for the northbound direction, and the second plot is for the southbound direction. The x-axis is the location on the corridor measured by absolute postmile with traffic moving from left to right on the plots while the y-axis is the time of day. The dark blue blotches indicate slow speeds and congestion. The vertical dotted lines identify the verified bottleneck location, which is labeled with a bottleneck number as listed in Exhibit 4-10.

There are three major bottleneck locations (labeled HOVN1 to HOVN3) in the northbound direction and three major bottleneck locations (labeled HOVS1 to HOVS3) in the southbound direction. The most significant major bottleneck in the northbound direction occurs at the Dyer interchange. This bottleneck and congestion occurs primarily during the PM peak period with congestion queues extending to the I-405 interchange, a distance of nearly two miles. The duration of this congestion is nearly four hours, from 3:00 PM to 7:00 PM.

The most significant major bottleneck in the southbound direction occurs at the Chapman interchange. This bottleneck and resulting congestion occurs primarily during the AM peak period, where queues can extend upstream about two miles. This bottleneck lasts about three hours from 6:00 AM to 9:00 AM. The bottleneck at the Edinger interchange, where the I-5 HOV direct connector merges into the SR-55 HOV lane, is also significant where it can last nearly four hours during the morning peak hours. Queues from this bottleneck can back up into the upstream bottleneck queues, for a combined length of seven miles.

Exhibit 4-11: Northbound & Southbound SR-55 HOV Lanes Speed Contour Plots (2010)





Source: Caltrans Performance Measurement System (PeMS) data

Bottleneck Area Analysis

Once the bottlenecks were identified and verified, the corridor is divided into major "bottleneck areas." A bottleneck area is a segment of the corridor between two major bottleneck locations. This should not be confused with queue lengths. Queue lengths are often shorter and within a bottleneck area, but can often extend to or past the next bottleneck area.

Dividing the corridor into bottleneck areas makes it easier to compare the various segments of the freeway with each other and some performance statistics presented earlier for the entire corridor can be segmented by bottleneck area. This way the relative contribution of each bottleneck area to the degradation of corridor performance can be gauged. Performance statistics that lend themselves to such segmentation include: Delay, safety, and productivity.

The analysis of directional bottleneck areas is based on 2010 data and is limited to the mainline facility. Exhibit 4-12 illustrates the general concept of bottleneck areas. The red lines in the exhibit represent the bottleneck locations and the arrows represent the bottleneck areas. The shaded shapes illustrate a textbook congestion profile with an illustrative queue behind each bottleneck.

Based on the above, the major bottlenecks previously identified in Exhibit 4-1 are shown again in Exhibits 4-13 and 4-14 with the associated bottleneck areas. Minor and hidden bottlenecks are not included in the bottleneck analysis areas.

Exhibit 4-12: Dividing a Corridor into Bottleneck Areas

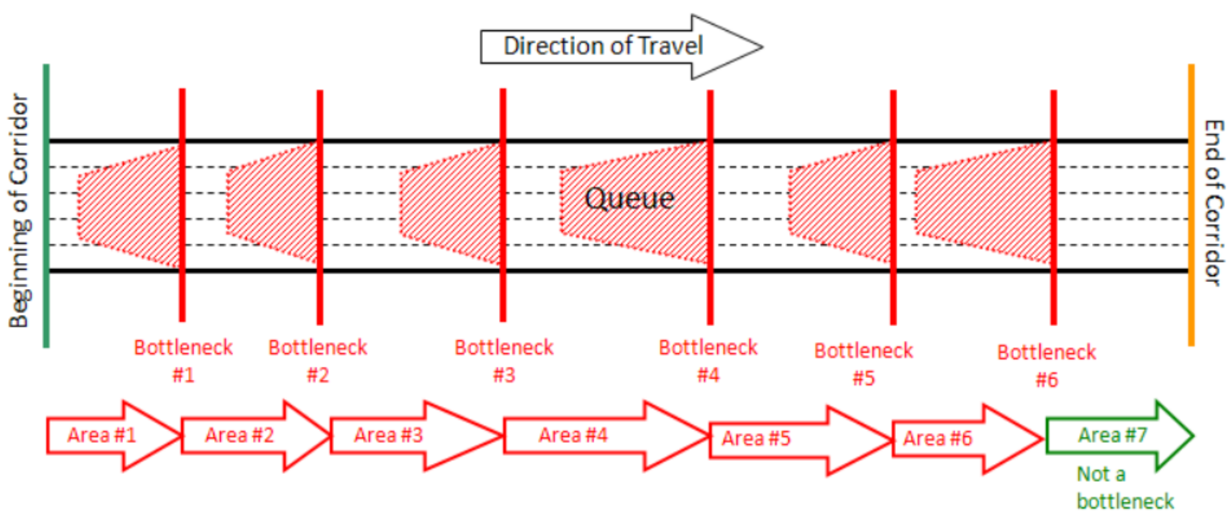


Exhibit 4-13: Orange County SR-55 Major Bottleneck Areas

Northbound

No.	Major Bottleneck Location	Bottleneck Area (Segment between Major Bottlenecks)	Active Period		From		To (At)		Distance (miles)
			AM	PM	Abs	CA	Abs	CA	
N1	NB Off to SB-405	Finley Avenue to SB-405 Off	✓		2.2	R2.2	5.7	R5.7	3.5
N2	Paularino C/D On	SB-405 Off to Paularino C/D On	☑	✓	5.7	R5.7	6.0	R6.0	0.3
N3	MacArthur On	Paularino C/D On to MacArthur On		✓	6.0	R6.0	7.2	R7.2	1.2
N4	Dyer On	MacArthur On to Dyer On		✓	7.2	R7.2	8.1	R8.1	0.9
N5	NB-5 Off	Dyer On to NB-5 Off	☑	✓	8.1	R8.1	10.0	10.0	1.9
N6	17th Street On	NB-5 Off to 17th On		✓	10.0	10.0	12.0	12.0	2.0
	None	17th On to SR91			12.0	12.0	17.9	17.9	5.9
									15.7

Southbound

No.	Major Bottleneck Location	Bottleneck Area (Segment between Major Bottlenecks)	Active Period		From		To (At)		Distance (miles)
			AM	PM	Abs	CA	Abs	CA	
S1	SR22 Off	SR91 to SR22 Off	✓	☑	17.9	17.9	13.0	13.0	4.9
S2	17 Street On	SR22 Off to 17th On	✓	☑	13.0	13.0	11.5	11.5	1.5
S3	I-5 On	17th On to I-5 On	✓	☑	11.5	11.5	10.0	10.0	1.5
S4	Edinger On	I-5 On to Edinger On	✓	✓	10.0	10.0	9.0	R9.0	1.0
S5	Baker Off	Edinger On to I-405 On		✓	9.0	R9.0	5.5	R5.5	3.5
	None	I-405 On to Finley Avenue			5.5	R5.5	2.2	R2.2	3.3
									15.7

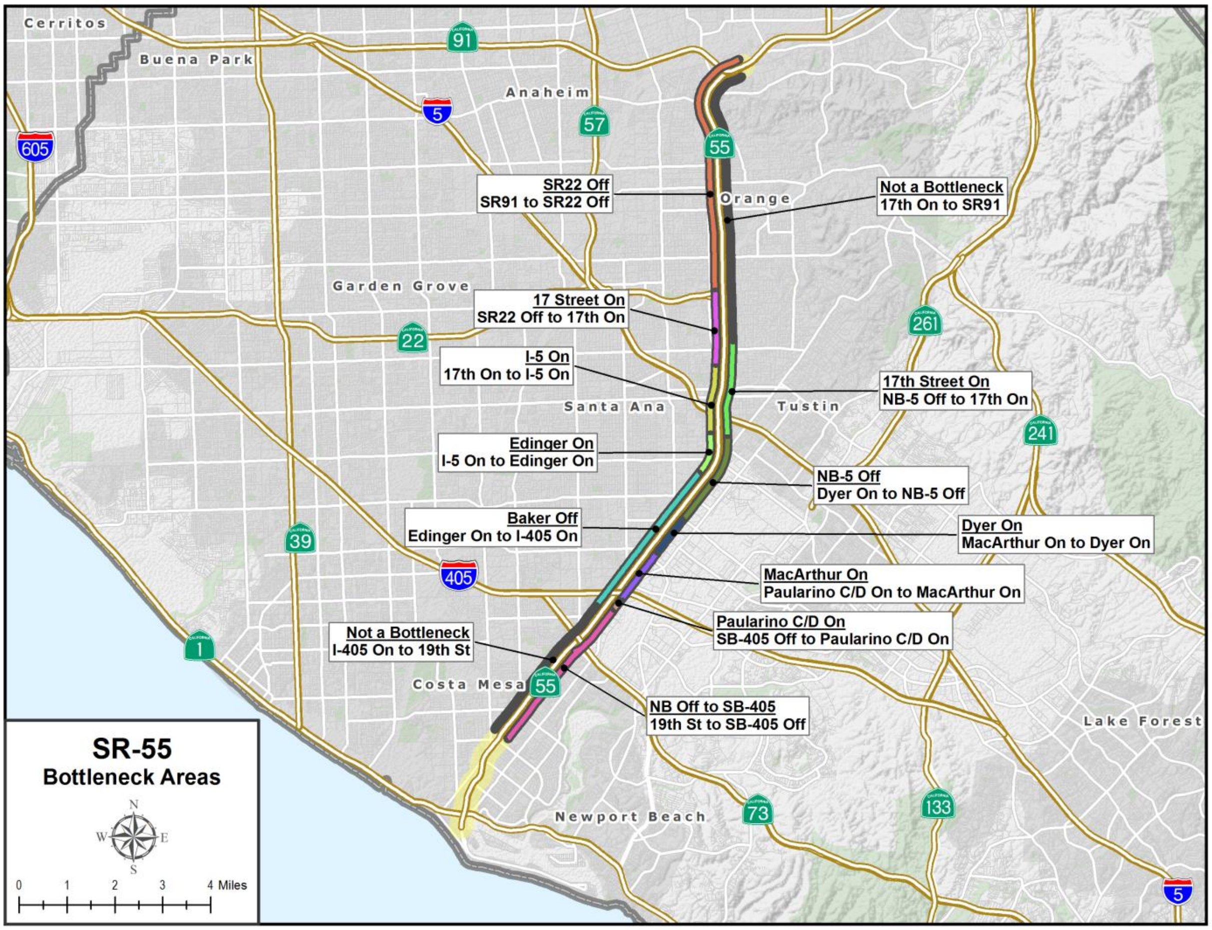
NOTES:

Bottleneck area is the segment from one major bottleneck location to the next major bottleneck location. It does not represent the queue length.

✓ Primarily active during this peak period

☑ Less congested bottleneck but also occurs during this peak period

Exhibit 4-14: Map of Orange County SR-55 Bottleneck Areas



MOBILITY BY MAJOR BOTTLENECK AREA

Mobility describes how efficiently the corridor moves vehicles, and the measure used to evaluate mobility for each bottleneck area is vehicle-hours of delay (vhd). Bottleneck areas with higher delays are areas that experience worse mobility and are candidates for projects that improve mobility.

Exhibit 4-15 reports the total annual vehicle-hours of delay experienced by each bottleneck area in 2011 for the northbound direction. Percentage delay is calculated for the AM and PM peak period separately. Exhibit 4-16 normalizes the northbound delay by lane-mile to measure the intensity of the delay. Traffic congestion on the corridor is directional by time period with delay in the northbound direction heavily concentrated in the PM peak period.

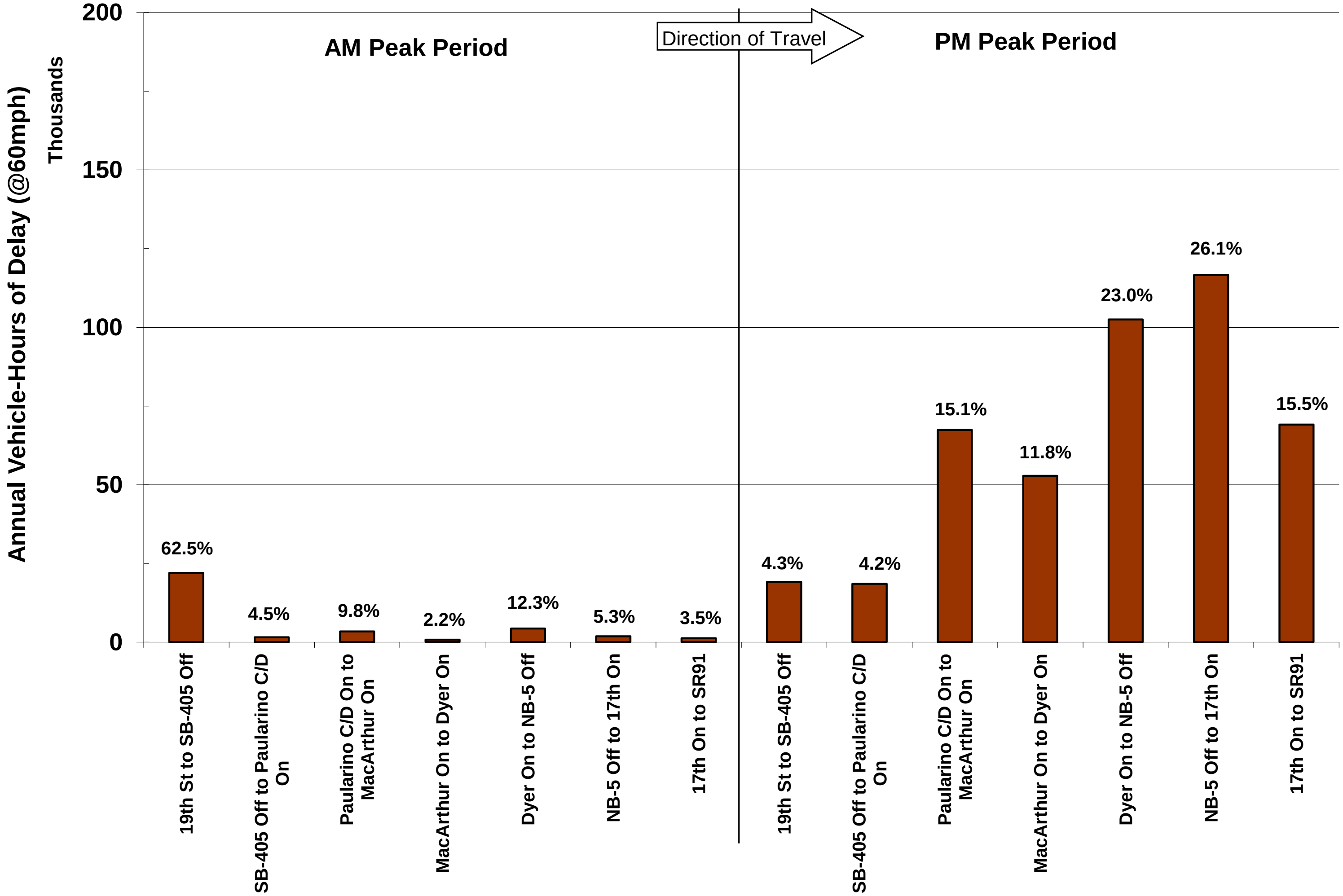
The segment between the northbound I-5 off ramp to the 17th Street on ramp (N6) experienced the greatest delay during the PM peak with around 26 percent of total PM peak period congestion (almost 120,000 annual vhd almost 18,500 vehicle-hours of delay per lane-mile).

Segment N5 between the Dyer on ramp to the I-5 off ramp also experiences major mobility issues representing nearly 23 percent of all northbound delay (approximately 100,000 annual vhd and 9,000 vhd per lane-mile).

Delay in the southbound direction is concentrated in the AM peak period. Exhibit 4-17 shows that the bottleneck area between SR-91 and SR-22 (S1) experienced the greatest delay during the AM peak with almost 170,000 annual vehicle-hours of delay (44 percent of the total AM peak delay), followed by the SR-22 off to 17th Street On bottleneck area (S2) at 23 percent), then by 17th On to I-5 On (S3 at 18 percent). When the intensity of delay experienced per lane-mile is examined, however, the I-5 to Edinger bottleneck area (S4) becomes significant while the SR-22 Off to 17th Street Off becomes less prominent (S3).

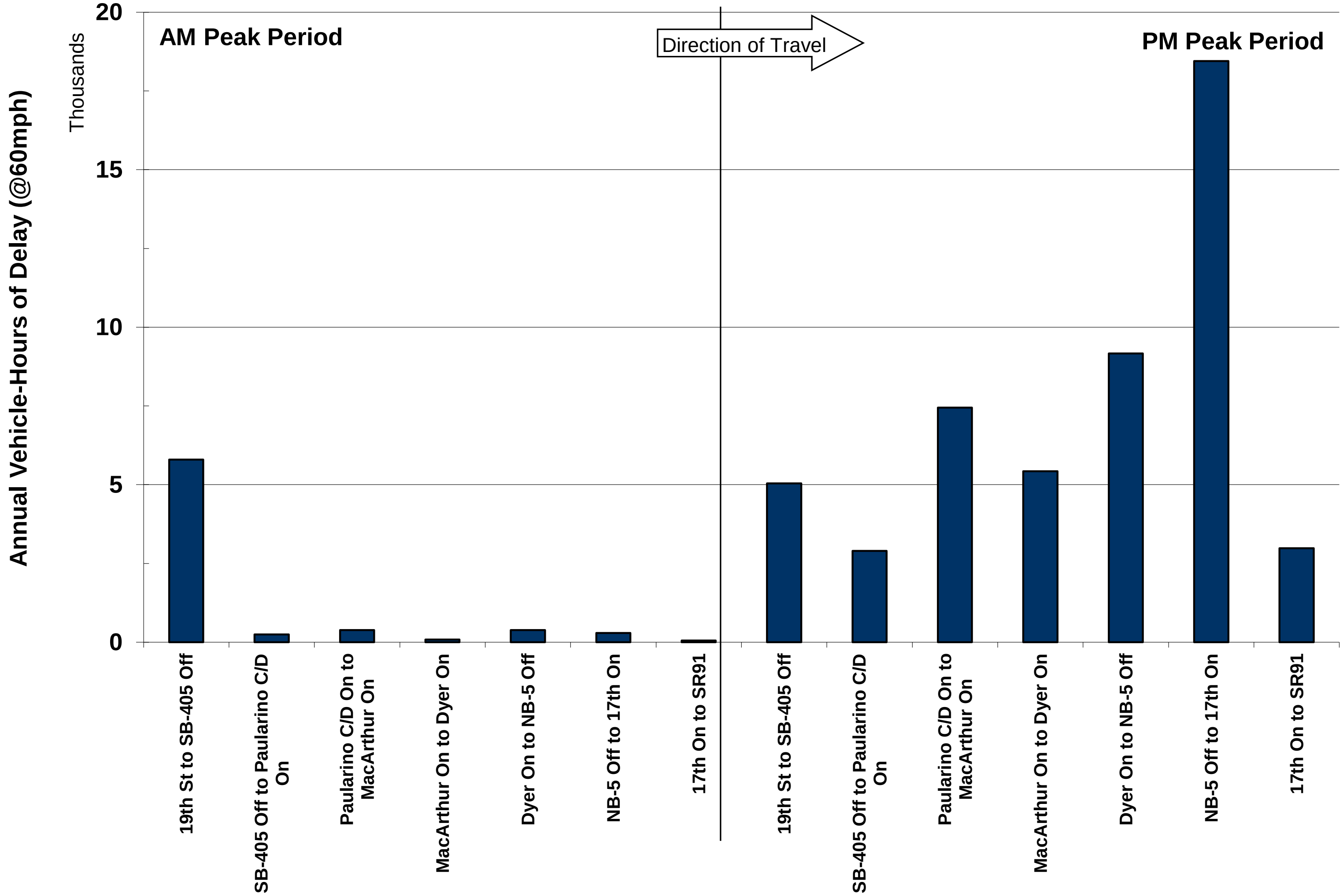
Although there is no major bottleneck located within the bottleneck area from I-405 to 19th Street, this segment experienced the greatest percentage of delay during the PM peak period with 65 percent of the southbound PM peak delay. Note that the primary congested time period in the southbound direction is the AM peak period.

Exhibit 4-15: Northbound SR-55 Annual Vehicle-Hours of Delay (2011)



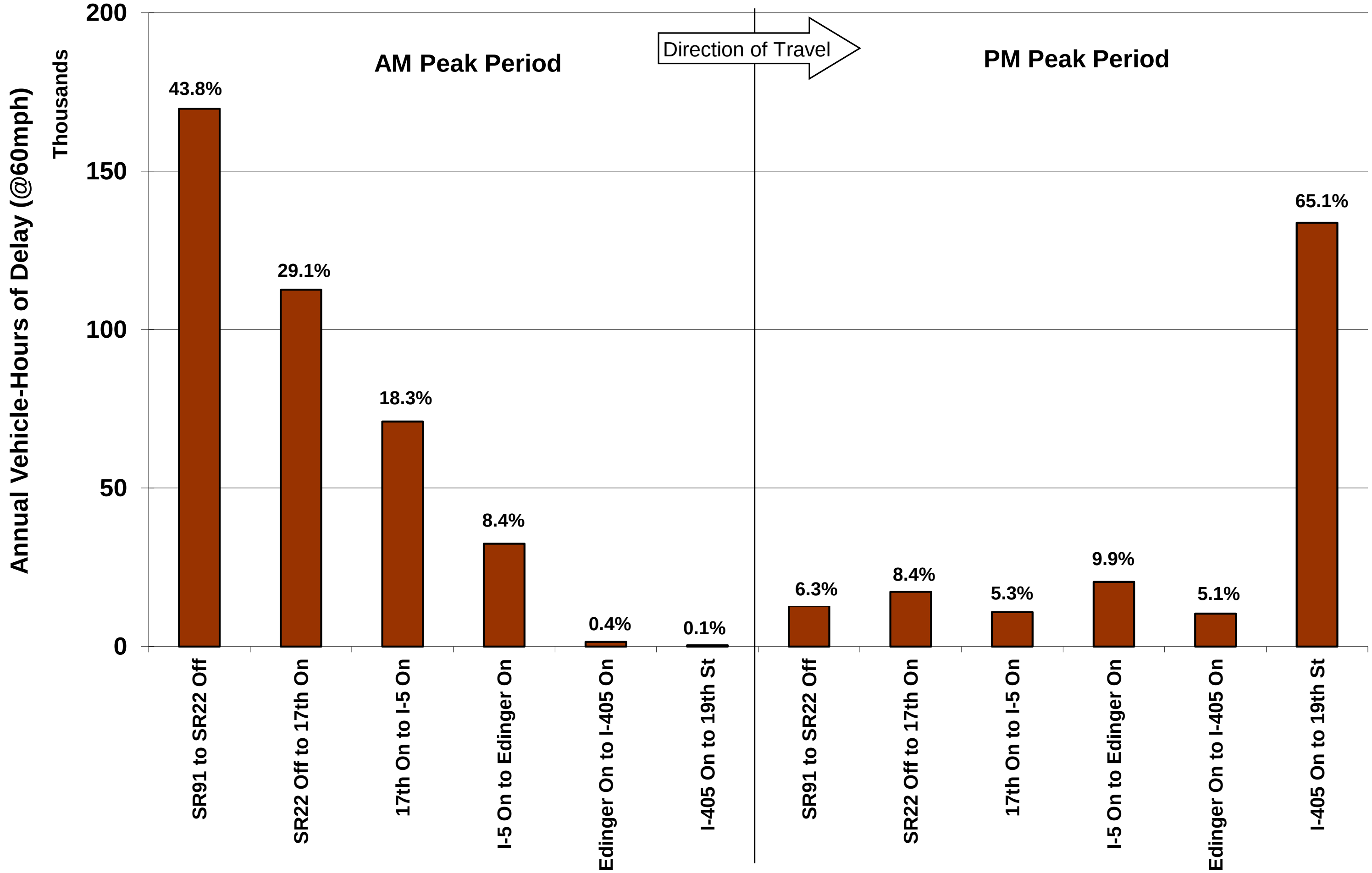
Source: Caltrans detector data

Exhibit 4-16: Northbound SR-55 Delay per Lane-Mile (2011)



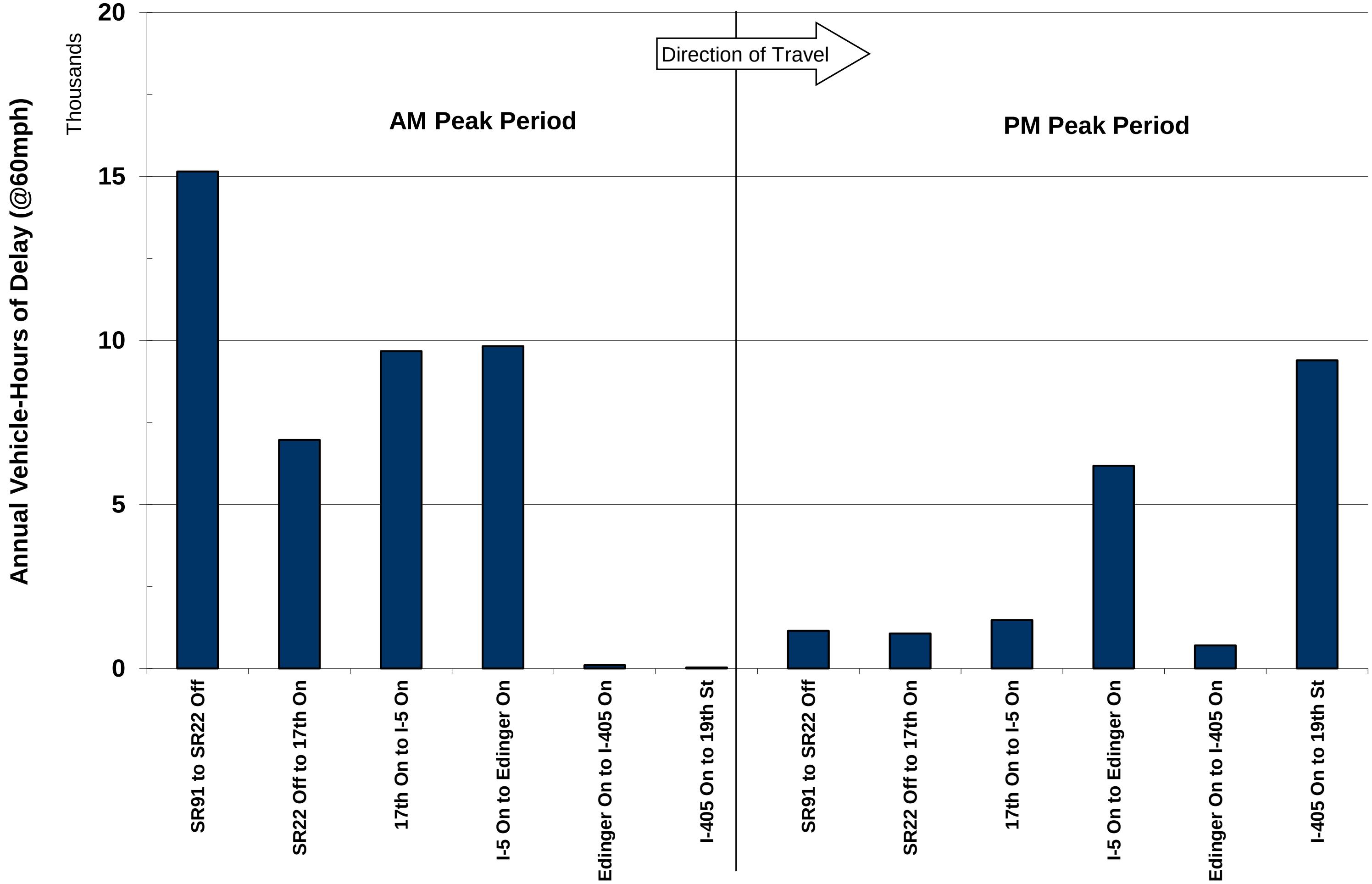
Source: Caltrans detector data

Exhibit 4-17: Southbound SR-55 Annual Vehicle-Hours of Delay (2011)



Source: Caltrans detector data

Exhibit 4-18: Southbound SR-55 Delay per Lane-Mile (2011)



Source: Caltrans detector data

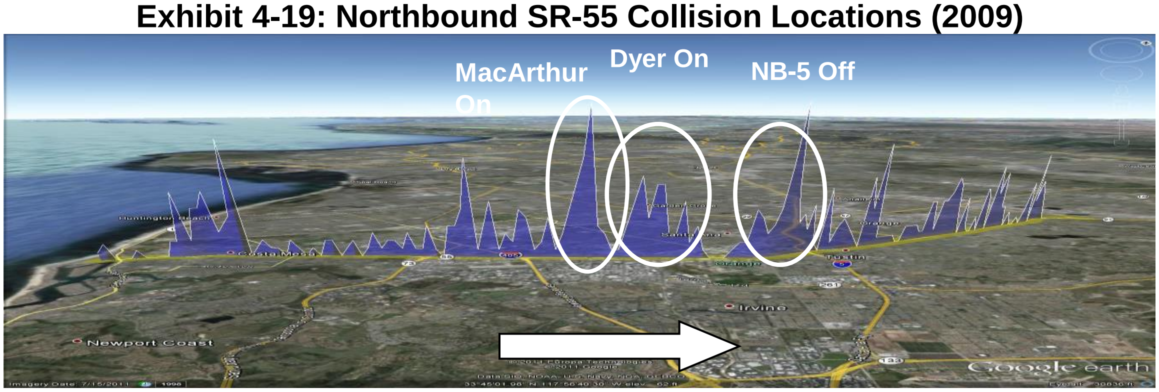
SAFETY BY BOTTLENECK AREA

The safety assessment in this report is intended to characterize the overall accident history and trends on the SR-55 corridor and to highlight notable accident concentration locations or patterns that are readily apparent. The following discussion examines the pattern of collisions by bottleneck areas for 2009 conditions. Due to the State's current budget constraints, safety by bottleneck area analysis updates for 2010 or later years cannot be performed at this time. Should future funding become available, this analysis will be updated.

Exhibit 4-19 shows the location of all collisions plotted along the corridor in the northbound direction. The spikes show the total number of collisions (fatality, injury, and property damage only) occurring within 0.1 mile segments in 2009. The highest spike corresponds to roughly 18 collisions in a single 0.1 mile location. The size of the spikes is a function of how collisions are grouped. If the data were grouped in 0.2 mile segments, the spikes would be higher.

As Exhibit 4-19 shows, the largest group of collisions occurred near the MacArthur, Dyer and Northbound I-5 interchanges. In many cases, a spike in the number of collisions occurred in the same location as a bottleneck. For example, a spike occurred at the MacArthur interchange, which is also a bottleneck location (N3).

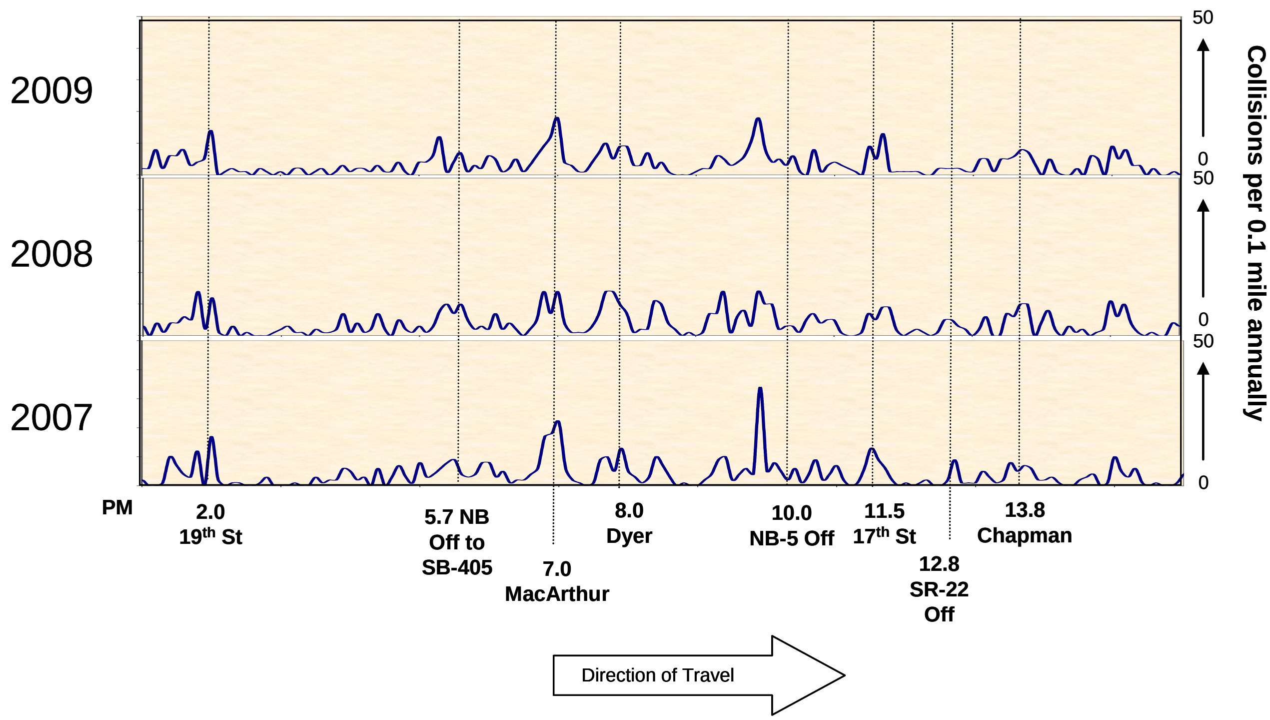
Exhibit 4-19: Northbound SR-55 Collision Locations (2009)



Source: Caltrans TASAS data

Exhibit 4-20 illustrates the same data for the three-year period from 2007 to 2009. The vertical lines in the exhibit refer to major bottleneck locations. The segments between the vertical lines correspond to bottleneck areas. This exhibit shows that the cluster of accidents near the MacArthur Boulevard interchange was higher in 2007 and decreased in 2008 and 2009. However, the pattern of collisions has stayed fairly consistent from one year to the next.

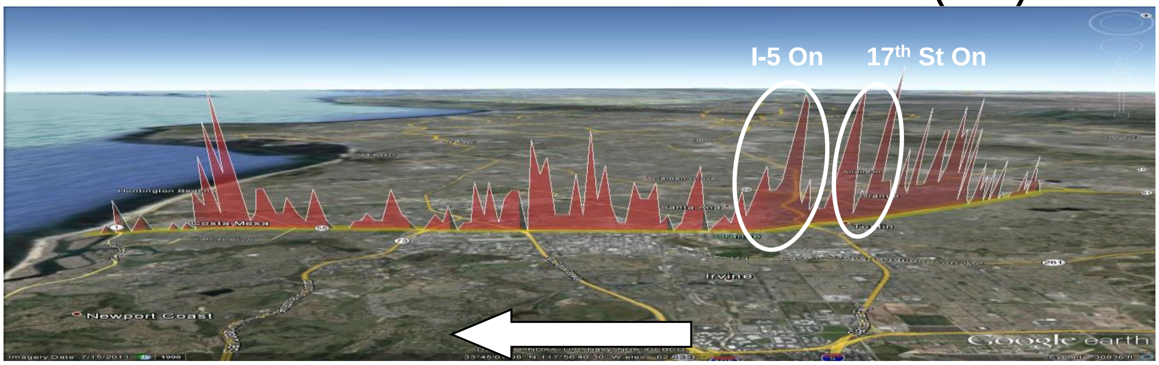
Exhibit 4-20: Northbound SR-55 Collision Locations (2007-2009)



Source: Caltrans TASAS data

Exhibit 4-21 shows the same 2009 collision data for the SR-55 in the southbound direction. The largest spike in this exhibit corresponds roughly to 16 collisions per 0.1 miles near the I-5 and 17th Street interchanges. The pattern in the southbound direction is similar to that in the northbound direction.

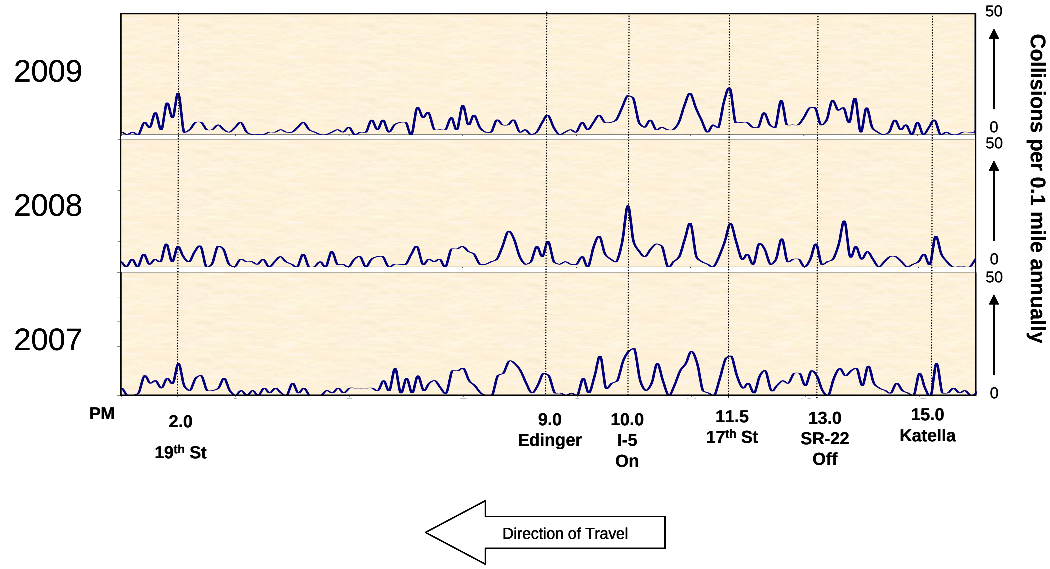
Exhibit 4-21: Southbound SR-55 Collision Locations (2009)



Source: Caltrans TASAS data

Exhibit 4-22 shows the trend of annual collisions for the southbound direction from 2007 to 2009. Similar to the northbound direction, the pattern of collisions have stayed consistent from year to year. It also shows the highest concentration of accidents occurred from I-5 to 17th Street.

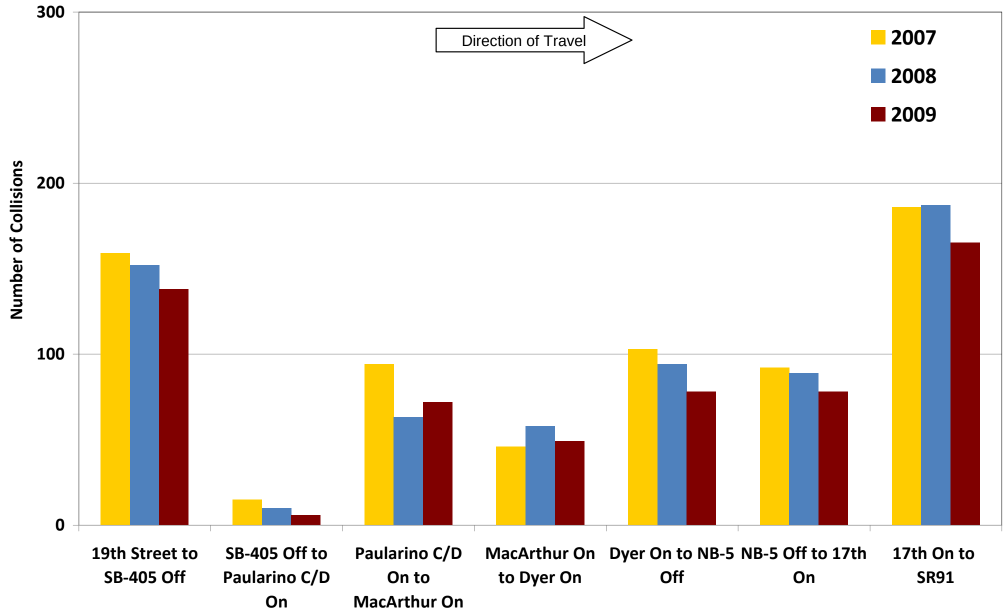
Exhibit 4-22: Southbound SR-55 Collision Locations (2007-2009)



Source: Caltrans TASAS data

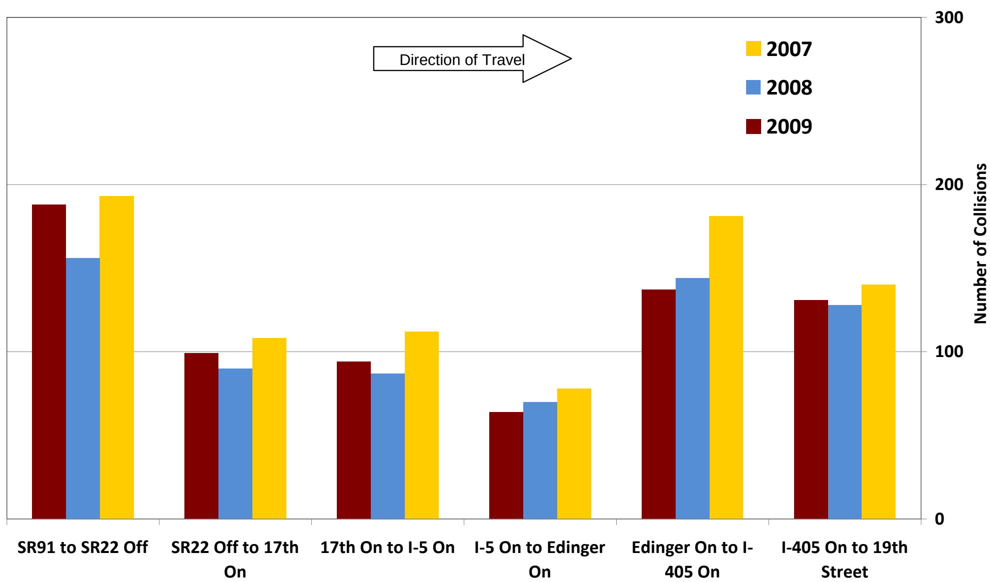
Exhibits 4-23 and 4-24 summarize the total number of accidents reported in TASAS by bottleneck area. The bars show the total number of annual accidents which occurred in 2007, 2008, and 2009 (the latest three years available in TASAS). In the northbound direction, the segment from 17th Street to SR-91 experienced the most accidents with roughly 185 each year followed closely by the segment from 19th Street to southbound I-405 with approximately 160 collisions. In the southbound direction, the segment from SR-91 to SR-22 experienced the most accidents with about 190 each year. In general, the bottleneck areas and longer segments experienced the most collisions along the corridor.

Exhibit 4-23: Northbound SR-55 Total Accidents (2007-2009)



Source: TASAS data

Exhibit 4-24: Southbound SR-55 Total Accidents (2007-2009)



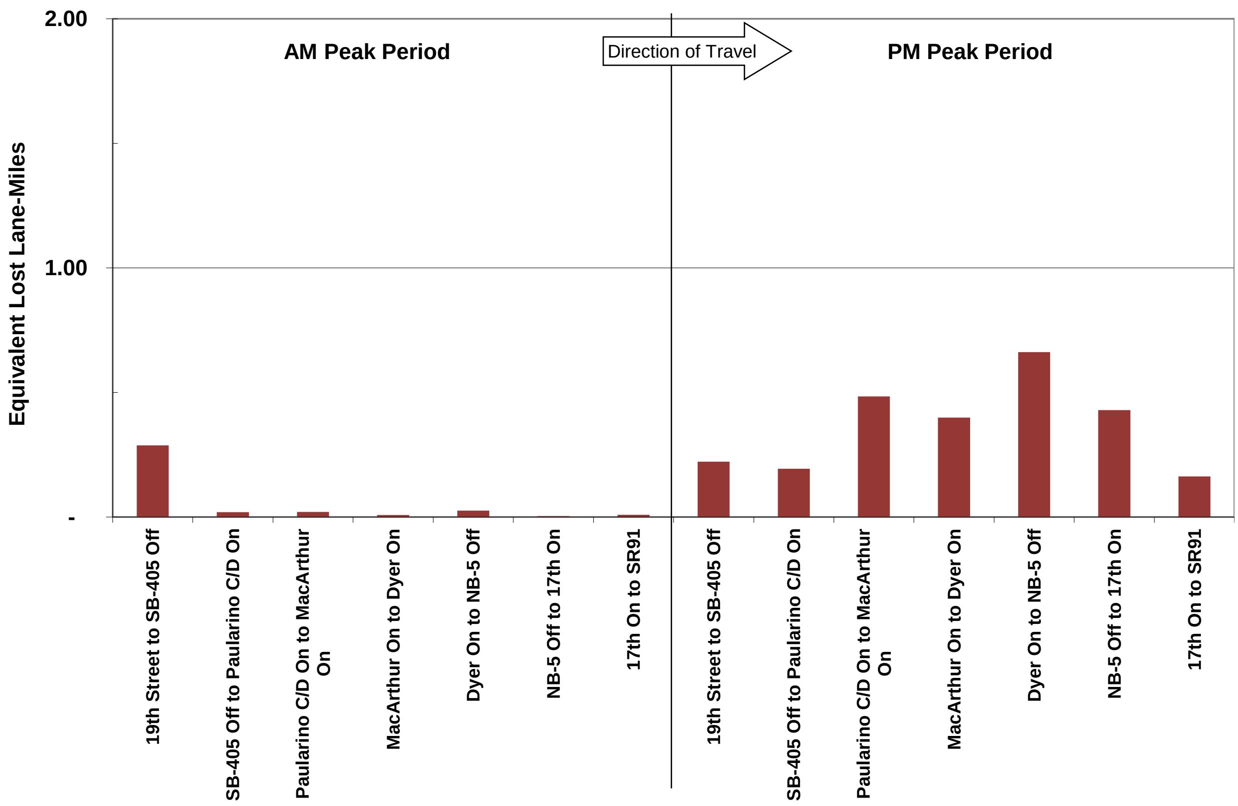
Source: TASAS data

PRODUCTIVITY BY BOTTLENECK AREA

As previously discussed in Section 3, the productivity of a corridor is defined as the percent utilization of a facility or mode under peak conditions. Productivity is measured by estimating the percent of capacity that is lost during peak periods when travel speeds drop below a specified threshold speed, in this case 35 mph. The number of lost lane-miles is calculated by multiplying the total number of lane-miles by the percentage of lost capacity. These lost lane-miles represent a theoretical level of capacity that would have to be added in order to achieve maximum productivity.

Exhibits 4-25 and 4-26 show the productivity losses for each direction of the corridor. In the northbound direction (Exhibit 4-25), the segment from the Dyer On to NB-5 Off (N5) had the worst productivity of any segment on the northbound corridor. It experienced a productivity loss of almost 0.7 lane-miles during the PM peak.

Exhibit 4-25: Northbound SR-55 Equivalent Lost Lane-Miles (2011)

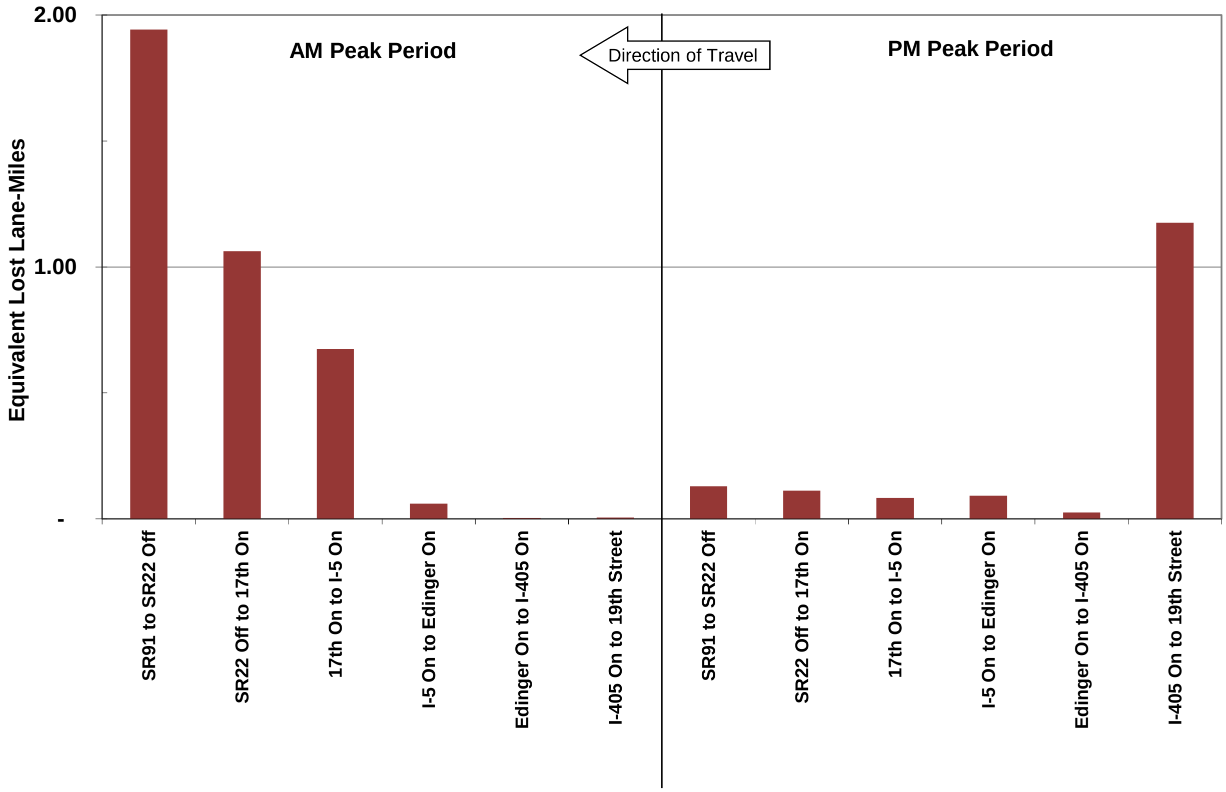


Source: Caltrans detector data

In the southbound direction (Exhibit 4-26), the segments that experienced the greatest productivity losses were from SR-91 to SR-22 (S1) during the AM peak with almost 2.0 lost-lane miles and from I-405 to 19th Street during the PM peak with over 1.0 lost lane-miles.

Since most productivity losses occur when there is severe congestion (i.e., speeds drop below 35 mph), the bottleneck segments with the highest productivity losses also experience the greatest annual vehicle-hours of delay.

Exhibit 4-26: Southbound SR-55 Equivalent Lost Lane-Miles (2011)



Source: Caltrans detector data

5. BOTTLENECK CAUSALITY ANALYSIS

This section details the causes of the bottlenecks identified in Section 4 of this report. Bottlenecks are the primary cause of traffic congestion and lost productivity. It is important to verify the precise location and causes of each major bottleneck to develop appropriate, operational improvements to maintain corridor mobility.

The location of each bottleneck was verified by multiple field observations on separate days as discussed in Section 4 of this report. The causes of each bottleneck were also identified by field observations and additional traffic data analysis.

By definition, a bottleneck is a condition where traffic demand exceeds the capacity of roadway facility. The cause of a bottleneck is typically related to a sudden reduction in capacity, such as a physical loss when a lane drop occurs or when heavy merging and weaving take place at on and off-ramps. On the demand side, surges in demand, often from on-ramps added to the mainline freeway already at or near the maximum flow rates, can be greater than a roadway can accommodate. In many cases, it is a combination of increased demand and capacity reductions.

Exhibit 5-1 summarizes the bottleneck locations, as presented in Section 4, and their main causes. Details of each bottleneck location and the cause(s) are presented in the remainder of this section.

Exhibit 5-1: Summary SR-55 Bottleneck Causes

Northbound

No.	Major Bottleneck Location	Hidden Bottleneck Location	Causality	Active Period		From		To (At)		Distance (miles)
				AM	PM	Abs	CA	Abs	CA	
N1	NB Off to SB-405		Auxiliary lane (2800+ feet) ends forcing merge into mainline	✓		2.2	R2.2	5.7	R5.7	3.5
N2	Paularino C/D On		Merging from collector/distributor road	☑	✓	5.7	R5.7	6.0	R6.0	0.3
N3A		NB On from NB-405	Merging	☑	✓			6.5	R6.5	
N3	MacArthur On		Merging (consecutive ramps)		✓	6.0	R6.0	7.2	R7.2	1.2
N4	Dyer On		Merging (consecutive ramps) with HOV ingree/egress merge		✓	7.2	R7.2	8.1	R8.1	0.9
N5	NB-5 Off		Lane ends at exit (mainline from 5 lanes to 4 at NB-5 to 3 at SB-5)	☑	✓	8.1	R8.1	10.0	10.0	1.9
N6B		NB On from NB-5	Merging		✓			10.8	10.8	
N6A		17th Street Off	Auxiliary lane (2000+ feet) ends forcing merge into mainline		✓			11.5	11.5	
N6	17th Street On		Merging (consecutive ramps)		✓	10.0	10.0	12.0	12.0	2.0
N7A		SR22 Off	Lane drop just past SR22 Off		✓			12.8	12.8	
N8A		Chapman Off	Lane drop just past Chapman Off		✓			13.8	13.8	
N9A		Lincoln Off	Lane drop just past Lincoln Off		✓			17.0	17.0	
	None					12.0	12.0	17.88	17.89	5.9
										15.7

Southbound

No.	Major Bottleneck Location	Hidden Bottleneck Location	Causality	Active Period		From		To (At)		Distance (miles)
				AM	PM	Abs	CA	Abs	CA	
S1A		Katella On	Merging	✓				15.0	15.0	
S1	SR22 Off		Lane drop south of SR22 Off (mainline from 4 lanes to 3)	✓	☑	17.9	17.9	13.0	13.0	4.9
S2	17 Street On		Merging and weaving with 4th Street Off	✓	☑	13.0	13.0	11.5	11.5	1.5
S3	I-5 On		Merging (consecutive connectors on)	✓	☑	11.5	11.5	10.0	10.0	1.5
S4	Edinger On		Merging	✓	✓	10.0	10.0	9.0	R9.0	1.0
S5	Baker Off		Lane drop south of Baker Off (mainline from 4 lanes to 3)		✓	9.0	R9.0	5.5	R5.5	3.5
S6A		19th St I/S	Seasonal bottleneck from heavy demand during midday summer months					2.0	R2.0	
	None					5.5	R5.5	2.2	R2.2	3.3
										15.7

NOTES:
Causality was verified with multiple field observations and video taping during November and December 2011.
Hidden bottlenecks are bottlenecks hidden by queuing from downstream bottleneck or demand held by upstream bottleneck(s).
✓ Primarily active during this peak period
☑ Less congested bottleneck but also occurs during this peak period

Northbound Mainline Facility

Southbound I-405 Off (N1)

The bottleneck condition at this location is caused by the traffic merging out of the auxiliary lane ending at the I-405 exit, and occurs mainly during the AM peak period. The mainline through lane reduces from four lanes to three through the I-405 interchange.

Paularino Collector/Distributor On (N2)

Paularino Collector/Distributor (C/D) On-ramp is a major bottleneck location that occurs mainly during the PM peak period. The main cause of this bottleneck location is the merging of traffic from Paularino C/D On-ramp. Exhibit 5-2 provides an aerial photograph view of this location.

Exhibit 5-2: Northbound SR-55 Bottleneck at Paularino Avenue C/D On-ramp

Source: System Metrics Group, Inc./Google Earth

Northbound I-405 On (N3A)

The bottleneck condition at I-405 connector on to northbound SR-55 is typically hidden by the congestion and queuing from the larger downstream bottleneck at MacArthur and Dyer (discussed in detail in the next section below), and occurs mainly during the PM peak period. The main cause of this bottleneck is the heavy volume of traffic merging from the connector, likely reducing the capacity.

MacArthur Boulevard On Ramp (N3)

MacArthur On is a major bottleneck location that occurs mainly during the PM peak period. The main cause of the bottleneck condition at this location is the merging of the consecutive on-ramps. Combined, they can reach over 1,500 vehicles per hour (vph) during the PM peak period, often exceeding the off-ramp traffic volume by 500 vph. The mainline traffic during this peak cannot accommodate this additional demand and results in the bottleneck condition.

Dyer Road On Ramp (N4)

Dyer On is also a major bottleneck location that occurs mainly during the PM peak period. The main cause of the bottleneck condition at this location is the merging of the consecutive on-ramps. Combined they can reach over 1,500 vehicles per hour (vph) during the PM peak period, often exceeding the off-ramp traffic volume by 1,000 vph. The mainline, already at fully saturated conditions cannot absorb this additional demand, resulting in the bottleneck condition. The vertical grade of the freeway over this interchange also impedes sight distance, contributing to the bottleneck condition.

Exhibit 5-3: Northbound SR-55 Bottleneck at Dyer On-ramp

Source: System Metrics Group, Inc./Google Earth

Northbound I-5 Off (N5)

The I-5 interchange is a major bottleneck location that occurs mainly during the PM peak period. The main cause of this bottleneck is the loss of mainline through lanes (to I-5 exit) on the northbound SR-55 at the interchange, from five lanes down to three lanes (one lane drops to Northbound I-5, from five lanes to four, and then another lane drops to Southbound I-5, from four lanes to three). The mainline demand exceeds the capacity of the three lanes resulting in the bottleneck. The bottleneck condition at this location is compounded by the queuing from the Northbound I-5 connector backing up onto the mainline and merging/weaving from the McFadden Avenue/Sycamore Avenue on-ramp traffic.

Exhibit 5-4: Northbound SR-55 Bottleneck at Exit to I-5

Source: System Metrics Group, Inc./Google Earth

Northbound I-5 On (N6B)

The bottleneck condition at I-5 connector on to northbound SR-55 is typically hidden by the congestion and queuing from the larger downstream bottleneck at 17th Street, and occurs mainly during the PM peak period. The main cause of this bottleneck is the heavy volume of traffic merging from the connector.

17th Street Off Ramp (N6A)

The bottleneck condition at the 17th Street Off-ramp is typically hidden by the congestion and queuing from the larger downstream bottleneck at the 17th Street On-ramps, and occurs mainly during the PM peak period. The main cause of this bottleneck is the heavy volume of traffic merging out of the auxiliary lane ending at the 17th Street exit, compounded by the weaving of the exiting traffic.

17th Street On Ramp (N6)

17th Street On is also a major bottleneck location that occurs mainly during the PM peak period. The main cause of the bottleneck condition at this location is the merging of the consecutive on-ramps. Combined they can reach over 1,500 vehicles per hour (vph) during the PM peak period, often exceeding the off-ramp traffic volume by 500 vph. The additional demand to the already fully saturated mainline traffic results in the bottleneck condition.

Exhibit 5-5: Northbound SR-55 Bottleneck at 17th Street On Ramp

Source: System Metrics Group, Inc./Google Earth

SR-22 Off, Chapman Avenue Off Ramp, Lincoln Avenue Off Ramp (N7A, N8A, N9A)

Although there was no indication of these locations being bottlenecks, all three locations have geometric configurations with a lane drop just past the off-ramps. When the demand on the mainline traffic is heavy, near full saturation, it is likely to result in a bottleneck condition.

Southbound Mainline Facility

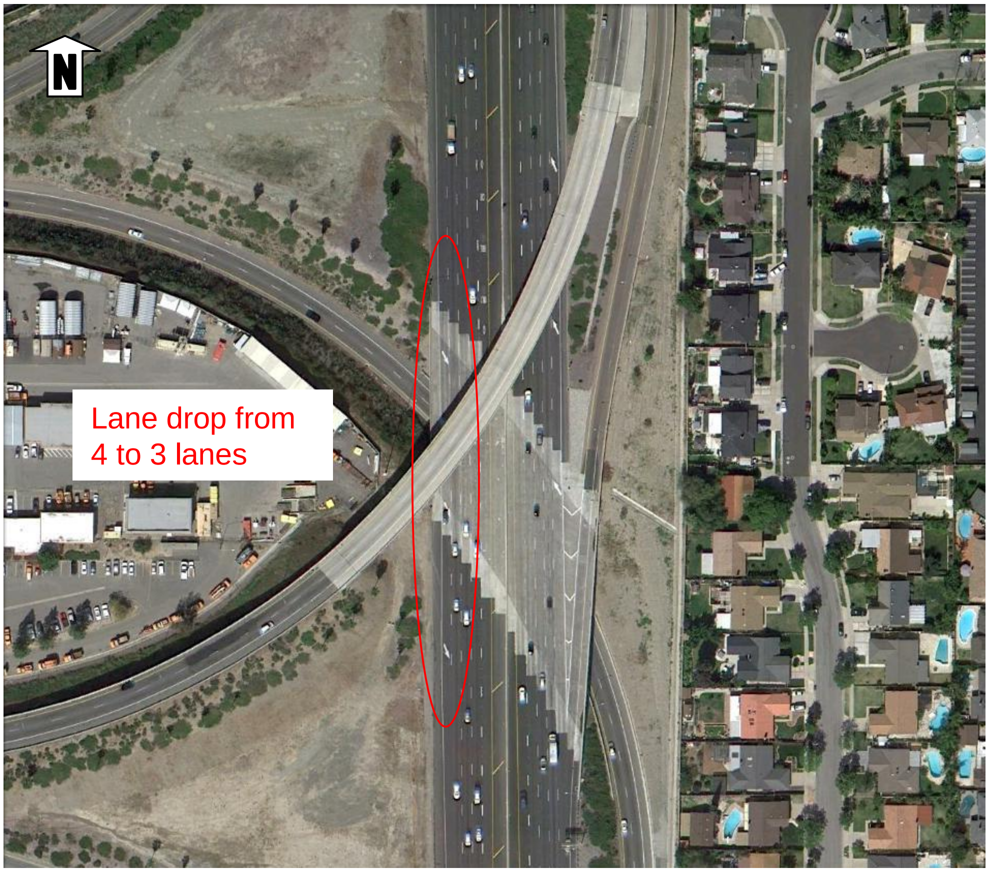
Katella Avenue On Ramp (S1A)

This is a hidden bottleneck location that occurs infrequently in the AM peak period. The main cause of this bottleneck is the merging from the on-ramp traffic.

SR-22 Off (S1)

The exit to SR-22 is a major bottleneck that occurs mainly in the AM peak period but also often occurs in the PM peak period. The main cause of this bottleneck is the lane drop from four lanes to three lanes just south of the exit to SR-22. This is compounded by the weaving from Chapman Avenue on-ramp traffic and the traffic exiting to SR-22.

Exhibit 5-6: Southbound SR-55 Bottleneck at South of Exit to SR-22 Off



Source: System Metrics Group, Inc./Google Earth

17th Street On Ramp (S2)

This is a major bottleneck location that occurs primarily in the AM peak period. The main cause of this bottleneck is the merging from the 17th Street on-ramp and weaving with the 4th Street off-ramp and SR-22 connector exiting traffic.

I-5 On (S3)

This is a major bottleneck location that occurs mainly in the AM peak period but also often occurs in the PM peak period. The main cause of the bottleneck at this location is the heavy traffic demand and merging from consecutive connectors from the I-5.

Edinger Avenue On Ramp (S4)

The bottleneck condition at this location occurred prior to the construction of the recent addition of the auxiliary lane from the Edinger on-ramp to the MacArthur off-ramp. The likely cause was the merging from the on-ramp, compounded by the lack of sight distance due to the vertical grade over this interchange. With the improvements, conditions are much better. Analysis of recent data suggests that although the bottleneck is still there, speeds are higher than before.

<u>Baker Street Off Ramp (S5)</u>

The bottleneck condition at Baker off-ramp currently is not major. Speeds sometimes slow to below 40 miles per hour, but rarely completely breaking down. The mainline demand is rarely saturated. The main cause of the slowdown is from the reduction from four lanes to three.

<u>19th Street (S6A)</u>

In the southbound direction, the freeway ends at the 19th Street intersection in Costa Mesa. The bottleneck condition at this location is seasonal primarily occurring in the summer during midday periods since SR-55 is one of the main routes to the beaches. Appendix A presents a performance assessment developed for summer traffic conducted by SMG. In 2010, congestion was heavy at this location often backing up traffic onto the freeway. In 2011, improvements at this intersection and the arterial street segment significantly improved the operating conditions at this location, reducing the congestion by nearly 80 percent.

Northbound HOV Facility

HOV bottlenecks also exist along the SR-55 corridor. For most of the HOV bottlenecks, the main cause is the congested slow speeds in the adjacent mainline lane. Motorists traveling on the HOV lane tend to slow down out of caution when the adjacent mainline lane experiences a significant reduction in speed. The bottlenecks for the northbound and southbound HOV facility are presented herein:

<u>Dyer Road On Ramp (HOVN1)</u>

This is a major bottleneck location that occurs in the PM peak period when speeds typically slow to below 30 miles per hour. The main cause of this bottleneck is the congested slow speeds in the adjacent mainline lane, the uphill grade, and limited sight distance. Motorists traveling on the HOV lane tend to slow down out of caution when the adjacent mainline lane experiences a significant reduction in speed.

<u>Exit to Northbound I-5 (HOVN2)</u>

This is a minor bottleneck location that occurs in the PM peak period where speeds typically slow to 30 to 40 miles per hour. The main cause of this bottleneck is the congested slow speeds in the adjacent mainline lane.

17th Street On Ramp (HOVN3)

This is a minor bottleneck location that occurs in the PM peak period where speeds typically slow to 30 to 40 miles per hour. The main cause of this bottleneck is the congested slow speeds in the adjacent mainline lane and the SR-22 bound traffic weaving out of the HOV lane.

Southbound HOV Facility

Chapman Avenue Off Ramp (HOVS1)

This is a major bottleneck location that occurs mostly in the AM peak period but sometimes also occurs in the PM peak period when speeds typically slow to below 20 miles per hour. The main cause of this bottleneck is the congested slow speeds in the adjacent mainline lane and the SR-22 bound traffic weaving out of the HOV lane.

17th Street Off Ramp (HOVS2)

This is a major bottleneck location that occurs mostly in the AM peak period but sometimes also occurs in the PM peak period when speeds typically slow to 30 to 40 miles per hour. The main cause of this bottleneck is the congested slow speeds in the adjacent mainline lane and the I-5 bound traffic weaving out of the HOV lane.

Edinger Avenue (HOVS3)

This is a major bottleneck location that occurs mostly in the AM peak period but sometimes also occurs in the PM peak period when speeds typically slow to 30 to 40 miles per hour. The main cause of this bottleneck is the merging from the I-5 HOV direct connector.

The bottleneck area between the Paularino Collector/Distributor to MacArthur Boulevard is one of the most congested bottlenecks in the northbound direction during the PM peak period. Based on simulation results shown in Section 6 of this report, the addition of a general purpose lane in the future dramatically reduces the congestion at this bottleneck location. Scenarios containing operational improvements such as auxiliary lanes and advanced ramp and connector metering also reduce congestion and provide good return on investment.

6. SCENARIO DEVELOPMENT AND MICRO-SIMULATION

The previous sections presented the diagnostic part of the CSMP describing the corridor, examining its performance trends, and pinpointing its bottleneck locations and related causes. This section describes the improvement evaluation component of the SR-55 CSMP effort. It describes the logic behind the scenario development framework using the Paramics micro-simulation model. It also summarizes the overall benefit-cost analysis results conducted to compare costs to benefits. The following steps are discussed in more detail below:

- Developing a traffic model based on current and medium-term demands
- Combining projects in a logical manner into “scenarios” for modeling and testing
- Evaluating model scenario outputs and summarizing results
- Conducting a benefit-cost assessment of scenarios

Traffic Model Development

In order to evaluate the effectiveness of the proposed projects, the modeling team developed an SR-55 traffic model using Paramics micro-simulation software.

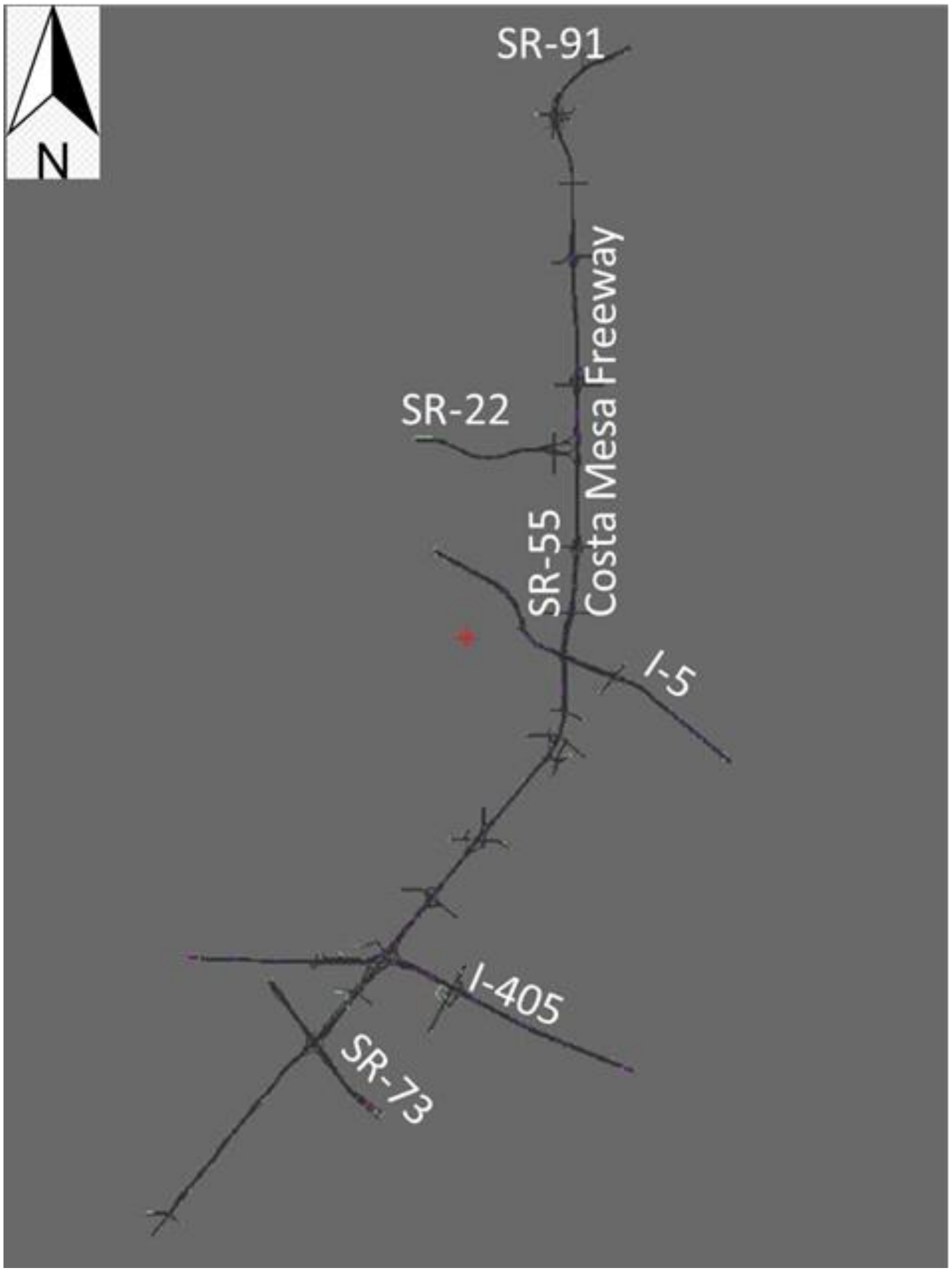
Micro-simulation models are complex to develop and calibrate for large congested urban corridors such as the SR-55 Corridor. However, it is one of the only tools capable of providing a reasonable approximation of bottleneck formation and queue development. Such tools help quantify the impacts of operational strategies, which traditional travel demand models cannot.

Micro-simulation models should typically start and end at areas with stable flow conditions in order to better estimate the demands of the model and replicate vehicles’ releasing patterns during simulation. Exhibit 6-1 shows the roadway network included in the SR-55 model that extends from SR-91 to the SR-55 terminus in the City of Costa Mesa. The model includes all freeway interchanges, arterial sections leading to these interchanges, and on- and off-ramps.

The model was calibrated against 2011 conditions. This was a resource intensive effort, requiring several review cycles until the model reasonably matched bottleneck locations and relative severity. The *Micro-simulation Model Calibration Report for SR-55 Orange County CSMP* is included under separate cover. Once the calibrated 2011 base year model was approved, a 2023 model was developed based on the Orange County Transportation Authority’s (OCTA) travel demand model demand projections. Caltrans agreed to use 2023 as the Horizon Year since micro-simulation models are better suited for short- to medium-term forecasting. The analysis does not account for latent demand beyond the OCTA demand forecast.

After calibration, these two models were used to evaluate different scenarios (combinations of projects) and quantify the associated congestion relief benefits. The results allowed the study team to compare the total benefits from each scenario with the associated project costs to assess the cost-effectiveness of improvements.

Exhibit 6-1: SR-55 Micro-Simulation Model Network



Source: Paramics Simulation Model

Scenario Development Framework

The study team developed a framework to combine projects into scenarios. Ideally, one would evaluate every possible combination of projects. However, this would entail thousands of model runs. Instead, the team combined projects based on a number of factors as follows:

- Fully programmed and funded projects were combined separately from projects that were not yet funded.
- Short-term projects were used to develop scenarios that can be tested with the 2011 and 2023 models.
- Long-term projects were used to develop scenarios tested only with the 2023 model.

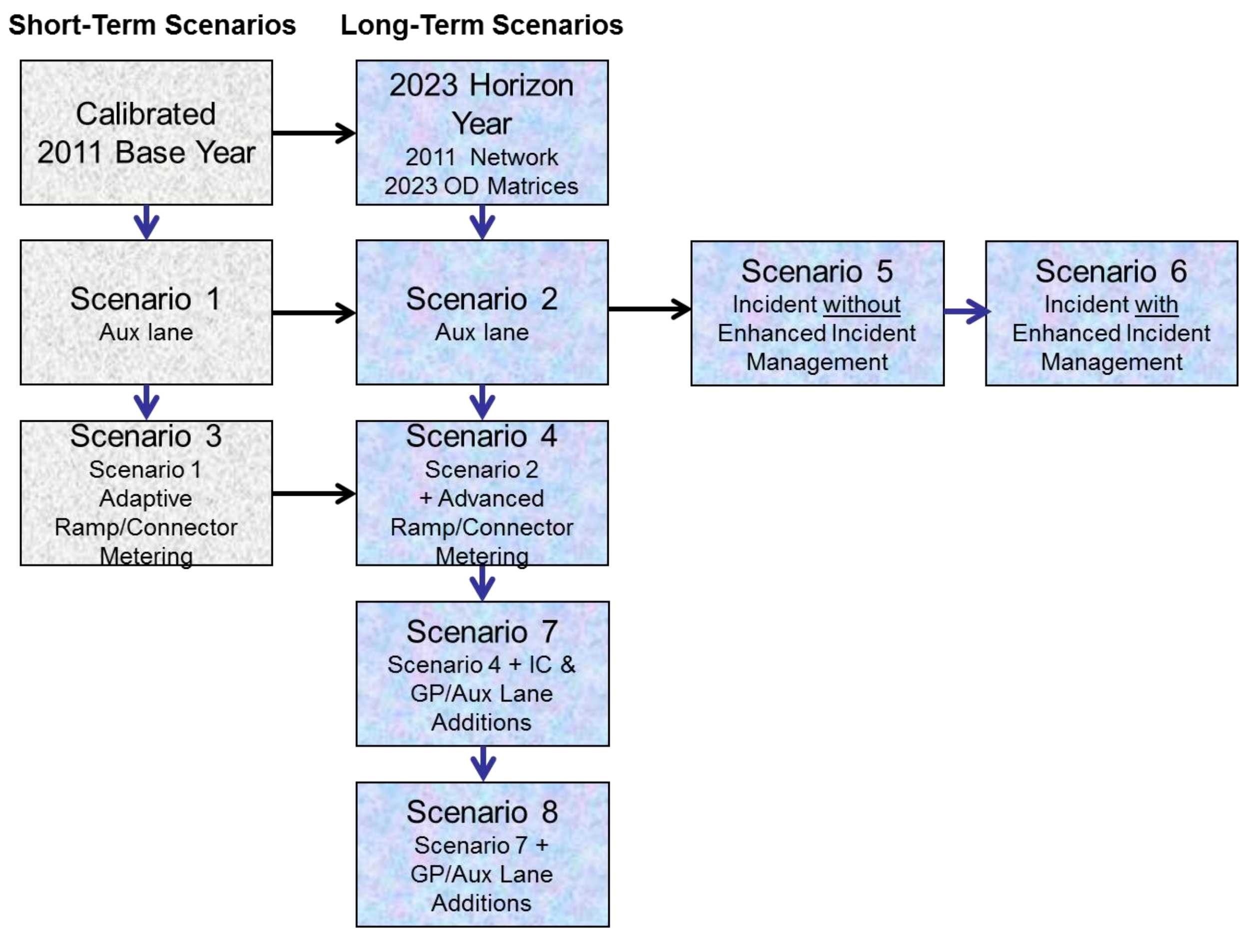
The study assumes that the 2011 base year model could support reasonable evaluations of projects developed by 2012. The 2023 horizon year for the SR-55 Corridor was extrapolated from the OCTA regional travel demand model origin-destination matrices. When OCTA updates its travel demand model and when the Southern California Association of Governments (SCAG) updates the Regional Transportation Plan (RTP), Caltrans may wish to update the micro-simulation model with revised demand projections.

The study team developed projects using project lists obtained from the Regional Transportation Improvement Program (RTIP), the Regional Transportation Plan (RTP), Measure M2, Caltrans Planning, and other sources such as special studies. Projects that do not affect mobility directly were eliminated. For instance, sound wall, landscaping, or minor arterial improvement projects were not evaluated since the primary (non-mobility) benefits of these projects are not captured in micro-simulation models.

Scenario testing performed for the SR-55 CSMP differs from traditional alternatives evaluations or Environmental Impact Reports (EIRs). These traditional studies focus on identifying alternative solutions to address current or projected corridor problems, so each alternative is evaluated separately and results among competing alternatives are compared, resulting in a locally preferred alternative. This contrasts with the CSMP approach. For the SR-55 CSMP, scenarios build on previous scenarios as long as the incremental scenario results show an acceptable level of performance improvement. This incremental scenario evaluation approach is important since CSMPs are often confused with alternatives studies.

Exhibit 6-2 summarizes the SR-55 modeling approach and the scenarios tested. The exhibit also contains general descriptions of the projects included in the 2011 and 2023 micro-simulation runs. Appendix B provides a detailed list of the projects included in each scenario.

Exhibit 6-2: Micro-Simulation Modeling Approach



Scenario Evaluation Results

Exhibits 6-3 and 6-4 show the delay results by facility type and peak period for all scenarios evaluated using the 2011 base year model. Exhibits 6-5 and 6-6 show the results for the scenarios evaluated using the 2023 horizon year model. The percentages shown in the exhibits indicate the difference in delay between the current scenario and the previous scenario (e.g., Percent Change = Current Scenario/Previous Scenario - 1). The impacts of strategies differ based on factors, such as traffic flow, available ramp storage, bottleneck locations, and congestion.

For each scenario, the modeling team produced results by facility type (i.e., mainline, HOV, and ramps) and vehicle type (SOV, HOV, trucks) as well as speed contour diagrams. The study team scrutinized these results to ensure consistency with general traffic engineering principles.

Exhibit 6-3: 2011 AM Peak Micro-Simulation Delay by Scenario

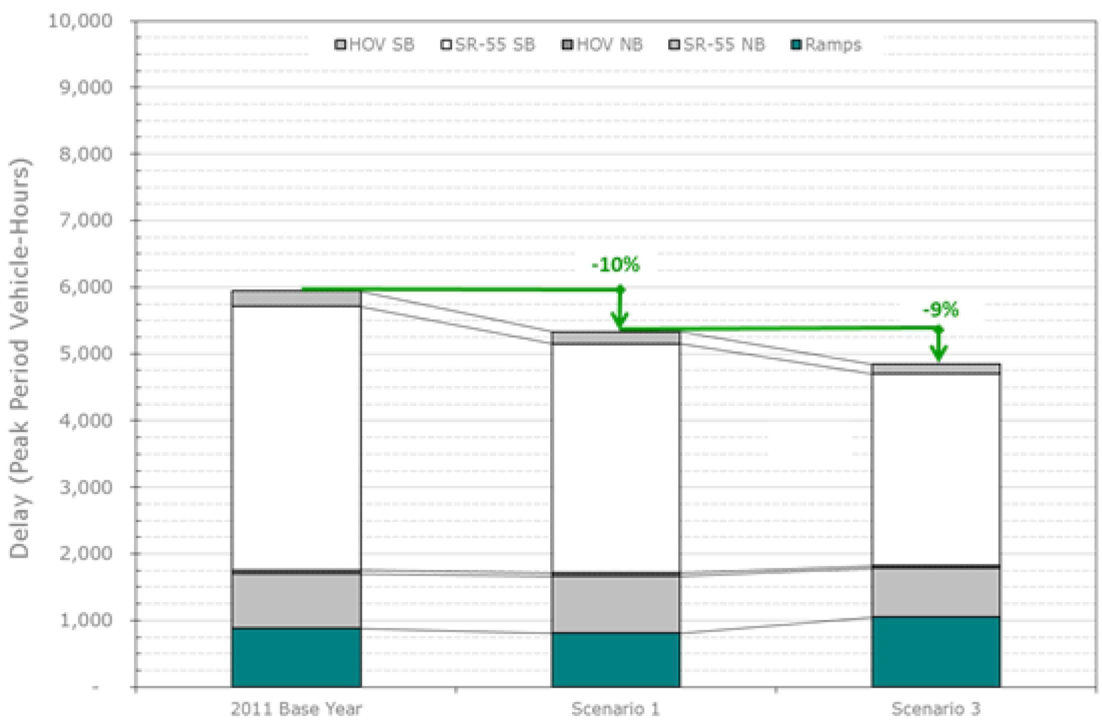


Exhibit 6-4: 2011 PM Peak Micro-Simulation Delay by Scenario

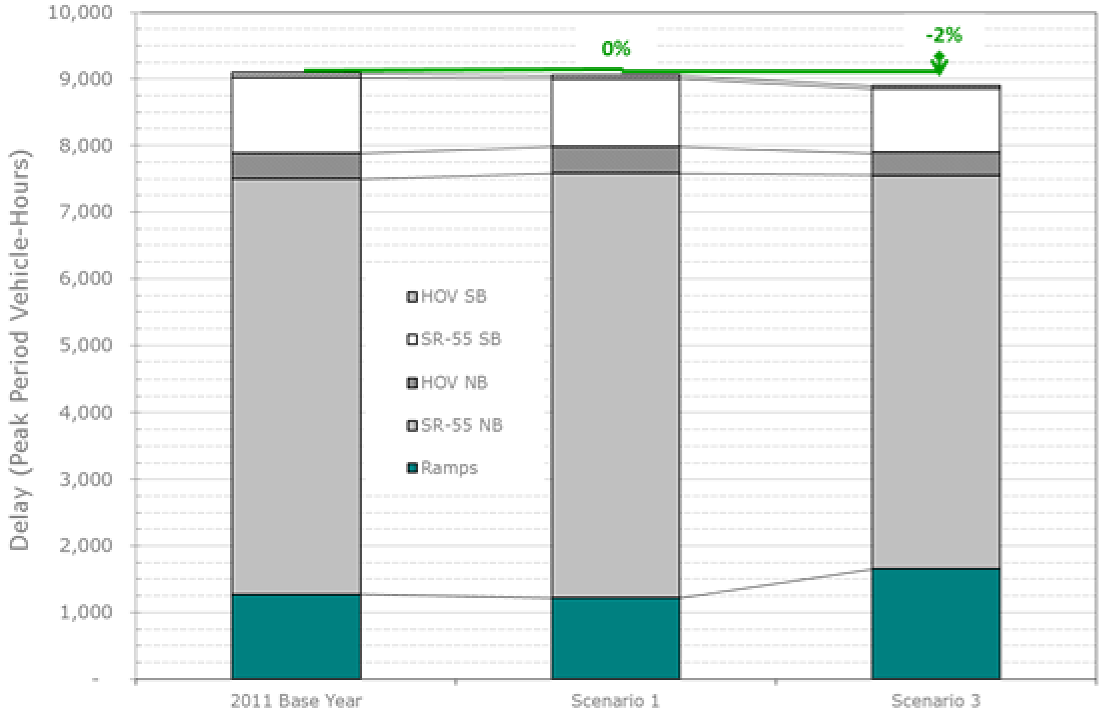


Exhibit 6-5: 2023 AM Peak Micro-Simulation Delay by Scenario

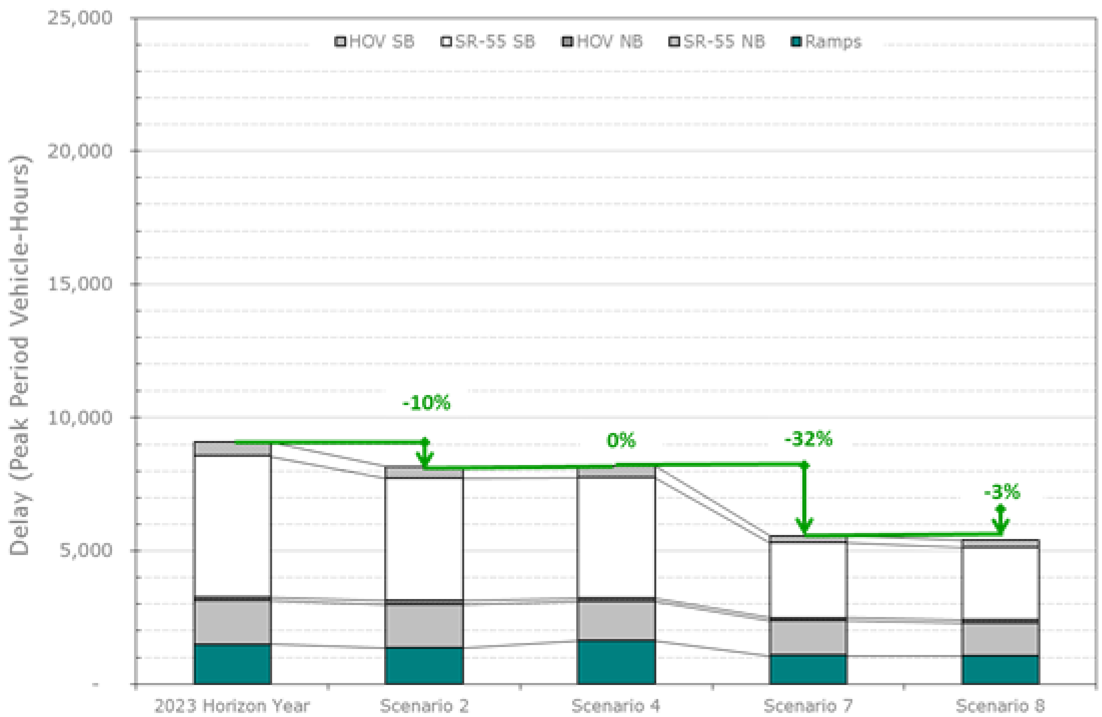


Exhibit 6-6: 2023 PM Peak Micro-Simulation Delay by Scenario

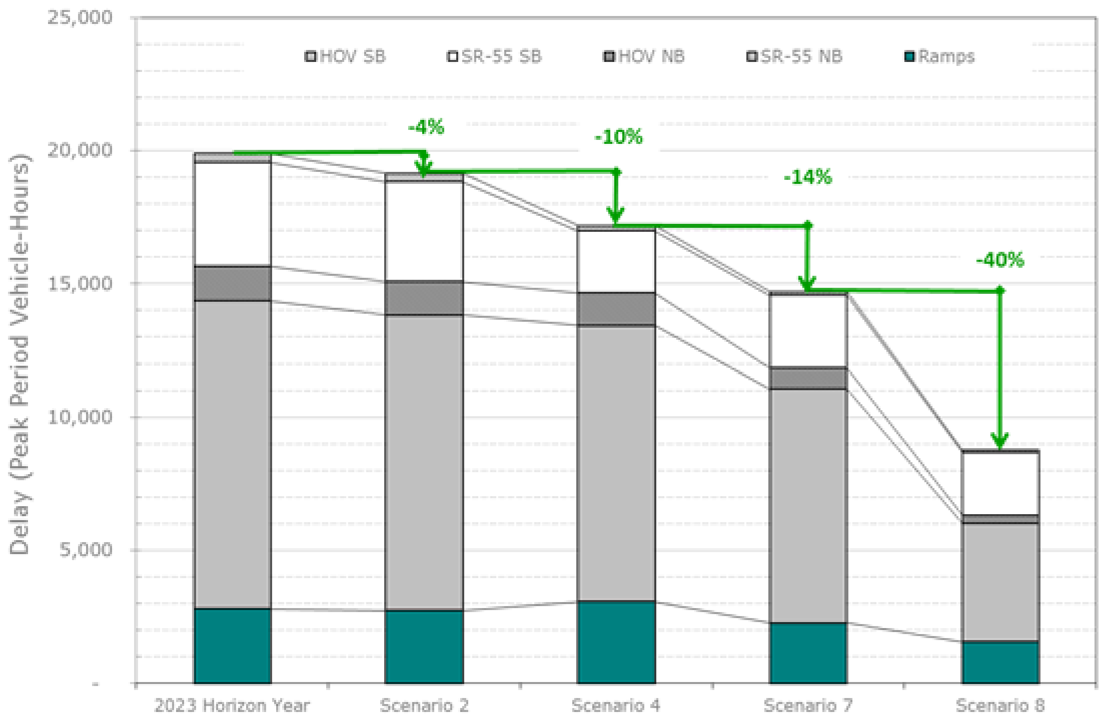


Exhibit 6-7: 2011 Northbound AM Delay by Scenario and Bottleneck Area

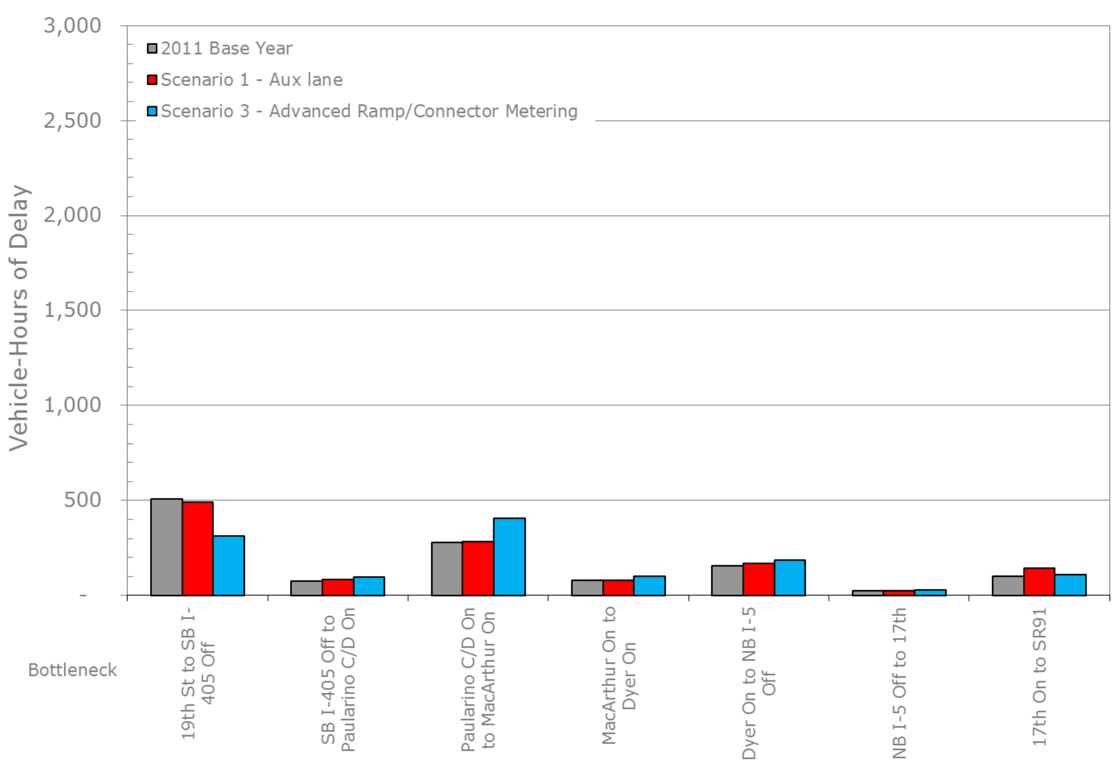


Exhibit 6-8: 2011 Northbound PM Delay by Scenario and Bottleneck Area

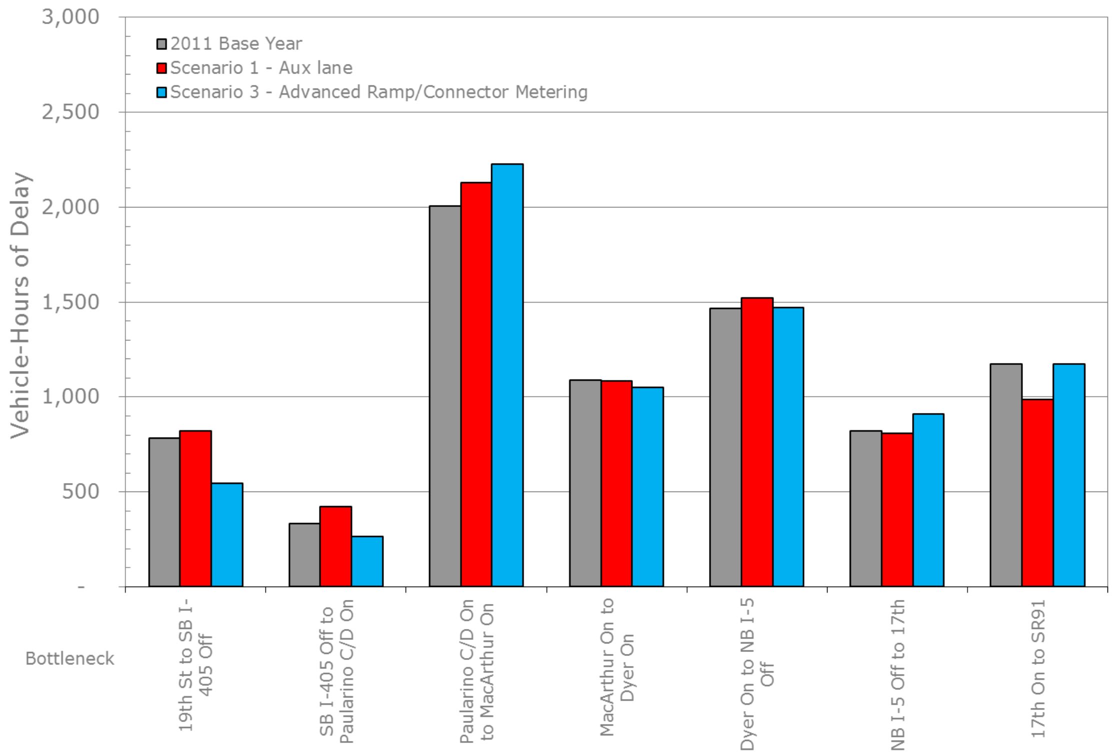


Exhibit 6-9: 2011 Southbound AM Delay by Scenario and Bottleneck Area

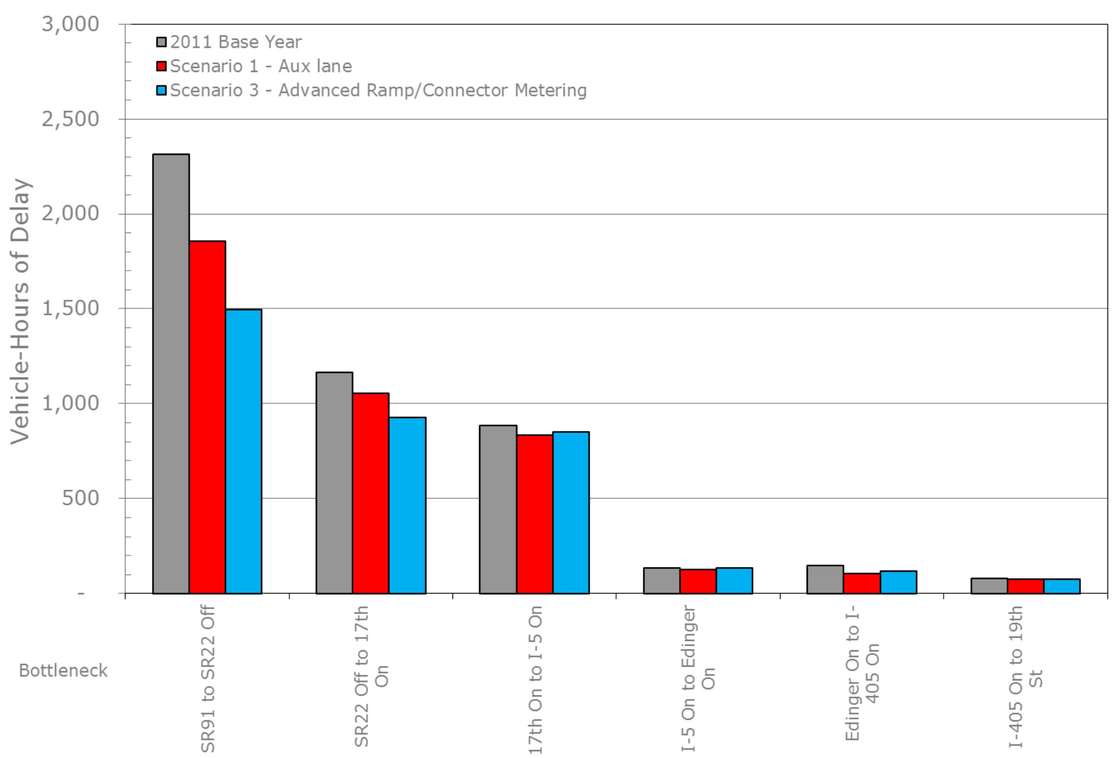


Exhibit 6-10: 2011 Southbound PM Delay by Scenario and Bottleneck Area

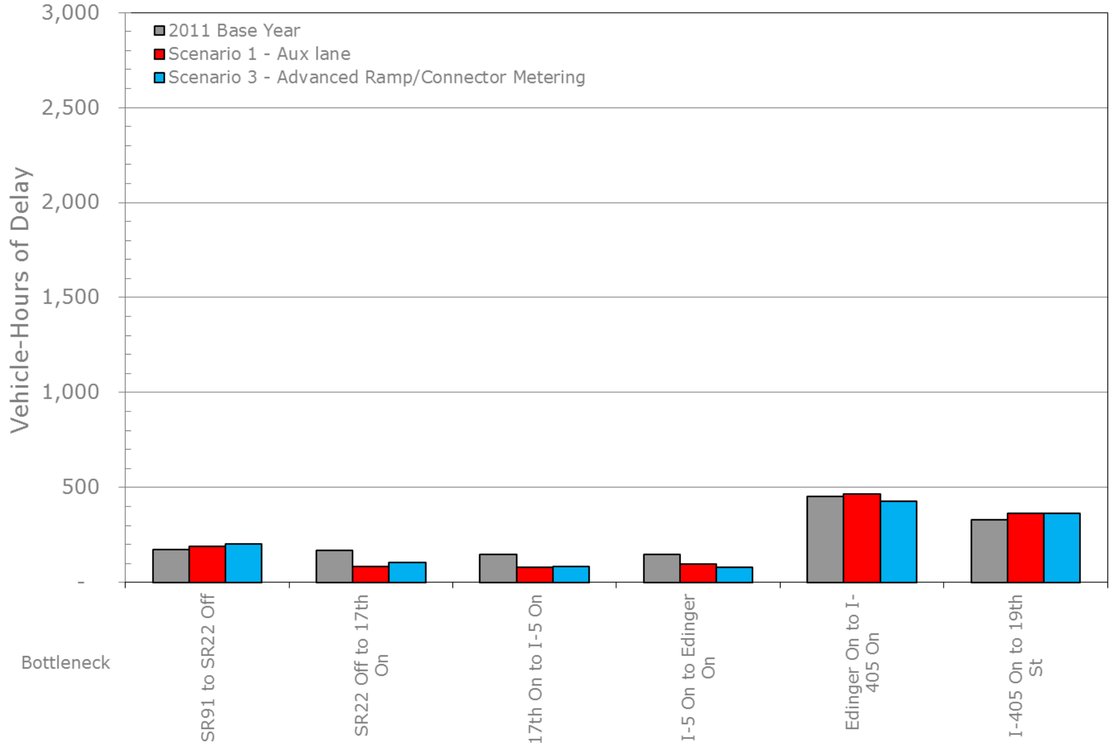


Exhibit 6-11: 2023 Northbound AM Delay by Scenario and Bottleneck Area

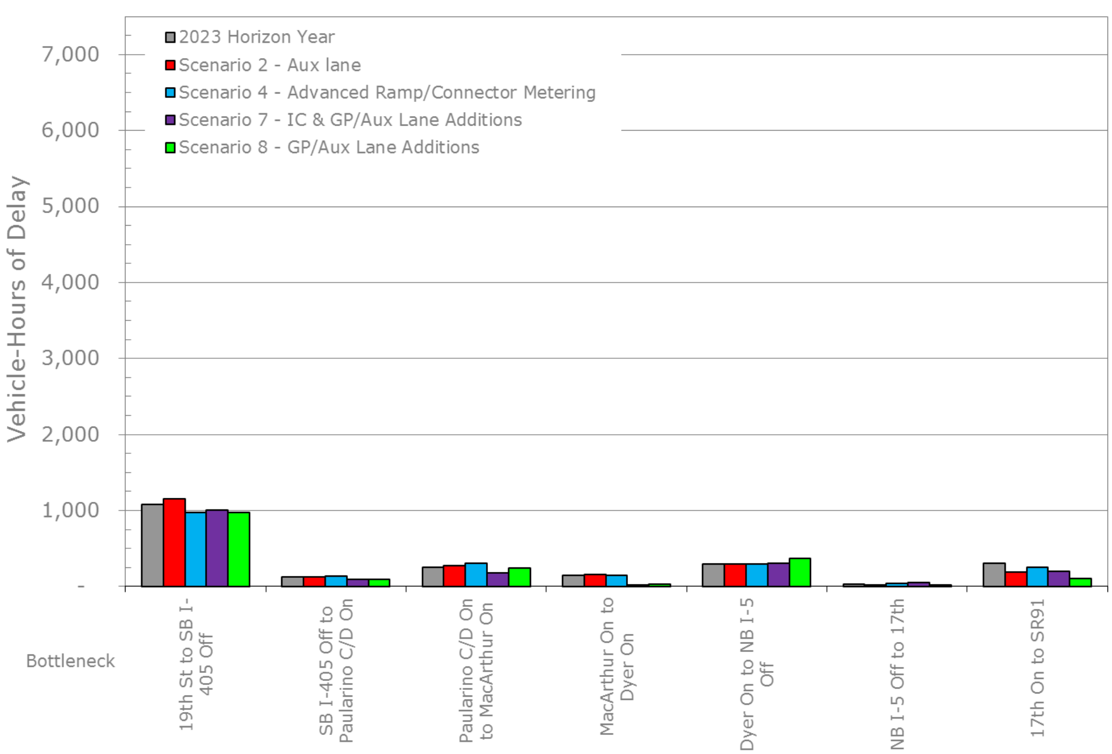


Exhibit 6-12: 2023 Northbound PM Delay by Scenario and Bottleneck Area

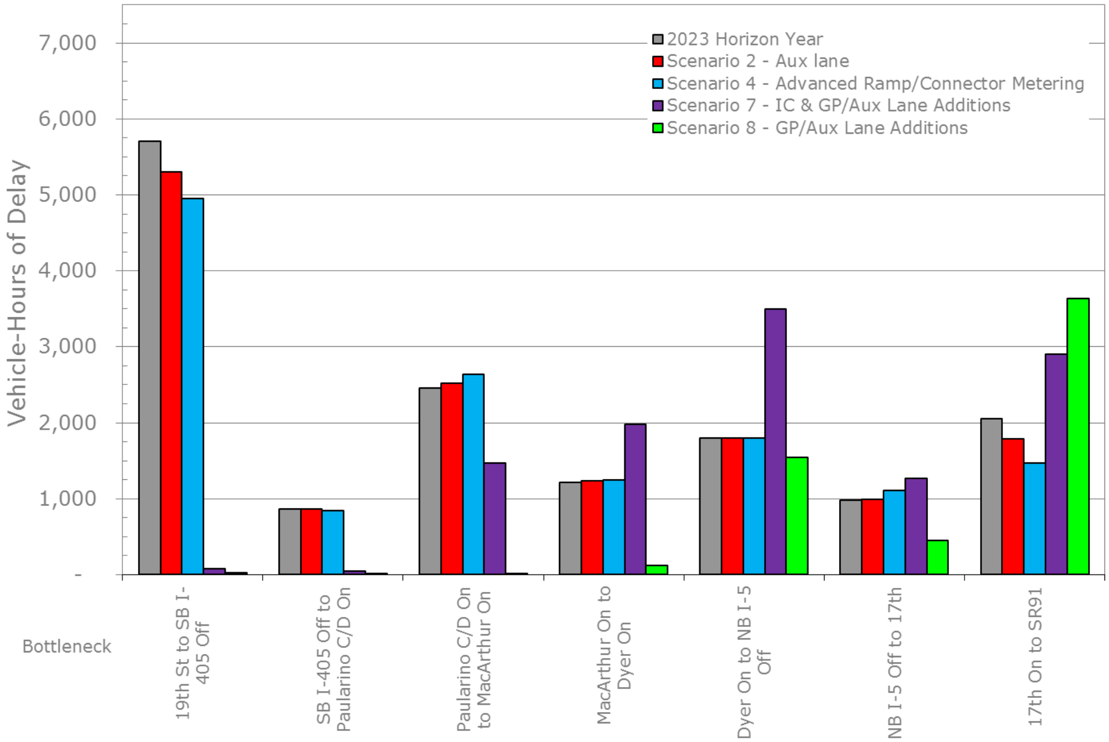


Exhibit 6-13: 2023 Southbound AM Delay by Scenario and Bottleneck Area

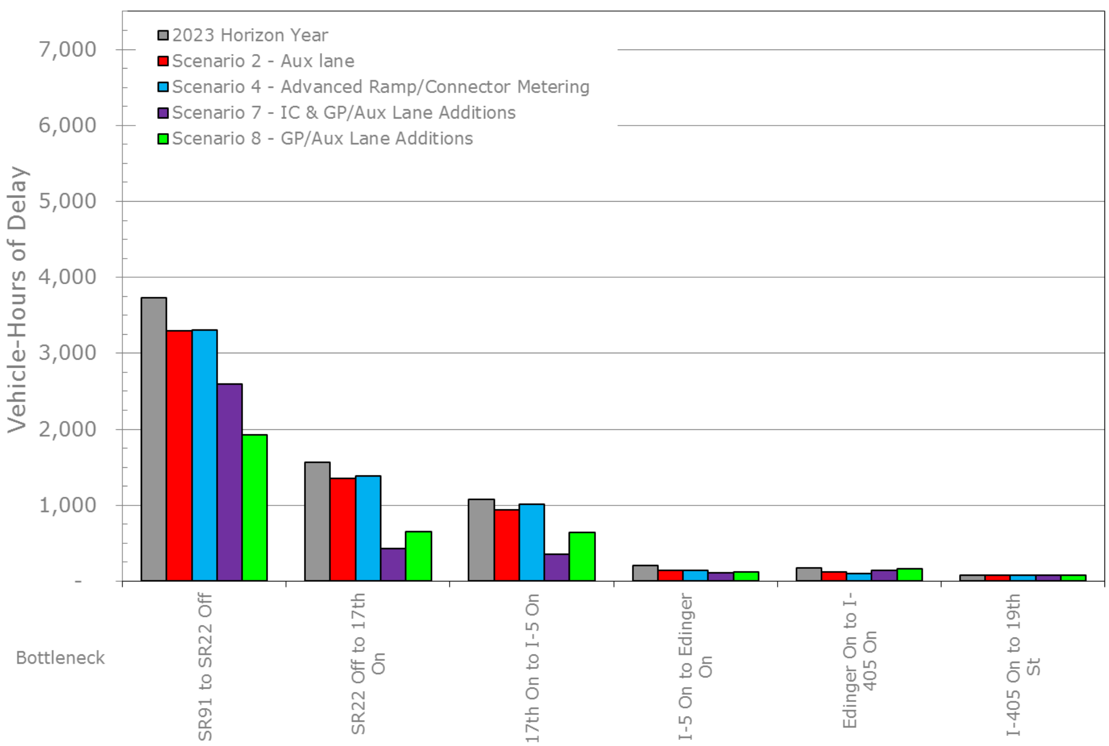
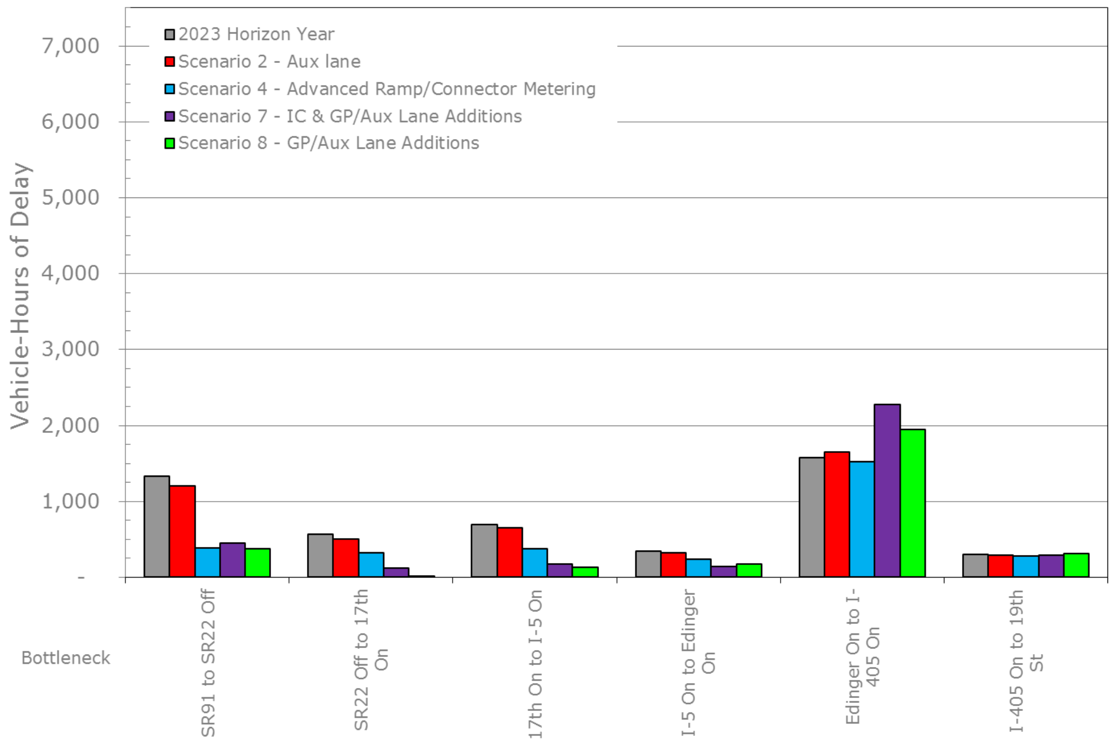


Exhibit 6-14: 2023 Southbound PM Delay by Scenario and Bottleneck Area



The following describes findings for each scenario tested by the study team:

Base Year and "Do Minimum" Horizon Year

Absent any physical improvements, the study team estimates that by 2023, total delay (mainline, HOV, and ramps) will increase by almost 200 percent compared to 2011 (from a total of around 15,000 daily hours to 29,000 daily hours) in the AM and PM peak hours. These forecasts do not reflect the economic conditions of the past few years and may overestimate the demand that will actually be experienced in 2023. However, demand is expected to grow over time and may eventually reach these levels. As described below, the short-term programmed projects lead to significant decreases and improved mobility on the corridor, regardless of when the anticipated growth in demand materializes.

Scenarios 1 and 2 (Auxiliary Lane)

The first two scenarios include a fully funded and programmed operations related project that was completed in 2012. This project constructed a southbound auxiliary lane between the East Edinger Avenue off-ramp to the Dyer Road off-ramp.

The 2011 model estimates that the project in the first scenario will reduce delay on the corridor by approximately 10 percent in the AM peak period with almost no change in the PM peak period. In total, this scenario estimates a reduction of almost 650 hours of daily delay. The majority of the delay reduction occurs in the southbound direction during the AM peak period. Mobility improves as a result of the additional weaving section available for entering and exiting vehicles between Edinger and Dyer.

The 2023 model estimates that the project will reduce delay on the corridor by 10 percent in the AM peak period and four percent in the PM peak period. Even with demand increases in 2023, this operational improvement project provides a large delay reduction benefit of almost 1,700 hours of daily delay.

Scenarios 3 and 4 (Advanced Ramp Metering, Connector Metering)

Scenarios 3 and 4 test advanced ramp and connector metering on top of implementing Scenarios 1 and 2. A series of several ramp and connector metering projects were tested as part of the scenarios:

- Implementing advanced ramp metering with queue control.
- Metering the southbound I-405 to northbound SR-55 connector ramp.
- Metering the northbound I-405 to northbound SR-55 connector ramp.
- Metering the northbound I-405 to southbound SR-55 connector ramp.
- Metering the southbound I-5 to southbound SR-55 connector ramp.

It should be noted that not all connector ramps were metered as part of the simulation based on a review of traffic conditions on connecting freeways (I-5 and I-405). It was determined that connector metering in some directions would produce negative impacts on the connecting freeway.

There are several types of advanced ramp metering systems deployed around the world. For modeling purposes, the study team used one developed in France called Asservissement Lineaire d’Entrée Autoroutiere (ALINEA). This algorithm has been deployed in Europe and Asia and the software was readily available for modeling. However, this algorithm is used as a proxy, so its use is not a recommendation for the SR-55 Corridor. Caltrans should evaluate different algorithms and implement the one it deems most beneficial.

The 2011 model indicates that the projects will improve delay in the AM peak period by nine percent and PM peak by two percent. For the 2023 model, ramp and connector delay increases exceed the delay improvements on the mainline and HOV facilities resulting in no delay reductions in the AM peak period. During the PM peak period, delays will improve by 10 percent overall, even with some ramp and connector delay increases. Although Scenarios 3 and 4 are estimated to reduce daily delay by almost 650 hours for the 2011 model and by over 1,900 hours for the 2023 model, advanced ramp metering and connector metering may not provide any improvements or benefits to the corridor under extremely congested conditions. It is also important to note that impacts of ramp metering are higher in the southbound direction, which suggests that initially implementing advanced ramp metering in this direction only may prove more effective.

Scenarios 5 and 6 (Enhanced Incident Management)

Three incident scenarios were tested on top of Scenario 2 to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. In Scenario 5, one collision incident with one outside lane closure was simulated in the southbound direction in the AM peak period model. In the northbound direction, one collision incident with one outside lane closure was simulated during the AM peak period and one during the PM peak period. The incident simulation location and duration was selected based on review of the 2011 actual incident data, at several of the high frequency locations. The following are the scenario details:

- Southbound AM peak period, close outermost mainline lane for 30 minutes at Post Mile 11.8 (at 17th Street).
- Northbound AM peak period, close outermost mainline lane for 30 minutes at Post Mile 7.0 (at MacArthur Boulevard).
- Northbound PM peak period, close outermost mainline lane for 40 minutes at Post Mile 9.4 (at Edinger Avenue).

As a result, the modeling represents a typical or moderate incident at one location during a peak period in each direction. Data suggest that incidents vary significantly in terms of impact and duration. Some incidents can last several hours, some close multiple lanes, and some occur at multiple locations simultaneously. There are also numerous minor incidents lasting only a few minutes without lane closures, yet still result in congestion. In addition, there are many incidents occurring during off-peak hours.

Based on actual Caltrans incident management data, it is estimated that an enhanced incident management system could reduce a 35-minute incident by about 10 minutes. An enhanced incident management system would require upgrading or enhancing the current Caltrans incident management system to include the deployment of intelligent transportation system (ITS) field devices, central control/communications software, communications medium (i.e. fiber optic lines), advanced traveler information system, and/or freeway service patrol (FSP) program to reduce incident detection, verification, response, and clearance times.

In Scenario 6, the same collision incident is simulated with a reduction in duration by 10 minutes to determine the benefits of an enhanced incident management system.

Exhibits 6-15 and 6-16 show the delay results by facility type and peak period for the enhanced incident management scenarios evaluated using the 2023 model. Without enhanced incident management, Scenario 5 produced a 21 percent increase in congestion in the AM peak and a six percent increase in the PM peak over Scenario 6 — a total increase of almost 3,000 hours of delay. The results indicate enhanced incident management would have little effect in the PM peak, but eliminate almost 1,000 hours of delay in the AM peak using 2023 demand. While these results capture benefits during the peak direction in the peak period, additional benefits could be realized during off-peak hours and in the off-peak direction.

Exhibit 6-15: 2023 AM Delay Results for Enhanced Incident Management

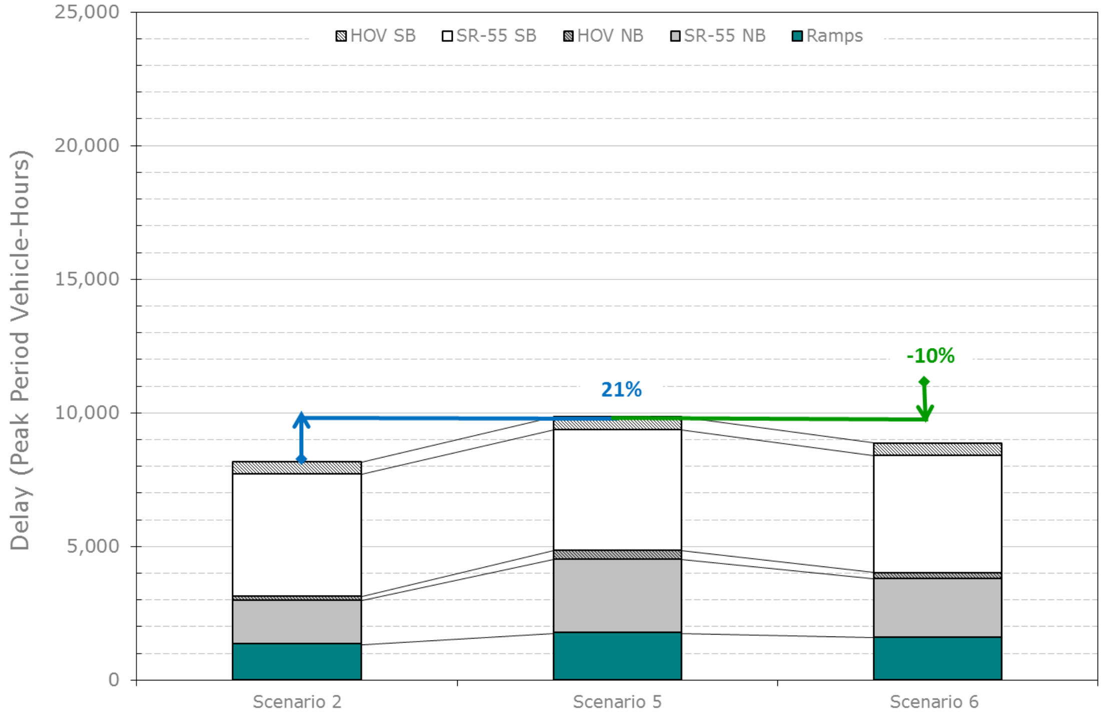
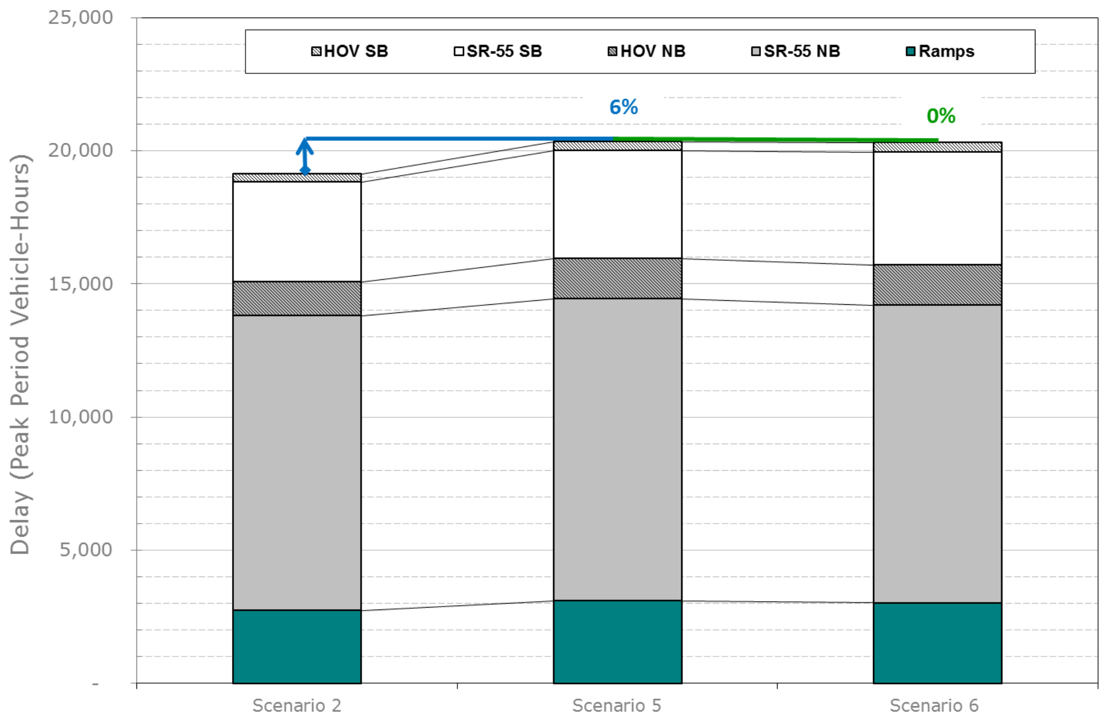


Exhibit 6-16: 2023 PM Delay Results for Enhanced Incident Management



Scenario 7 (Interchange, General Purpose and Auxiliary Lane Additions)

Scenario 7 adds several funded projects to the alternative modeled in Scenario 4:

- Constructing northbound and southbound on- and off-ramps and auxiliary lanes at the Meats Avenue interchange.
- Adding general purpose and auxiliary lanes and interchange improvements between I-405 and I-5. This project is being funded through OCTA's M2 Freeway Program and is identified in OCTA's M2020 Plan as Project F, Phase I.

The 2023 model shows that the combination of these two projects will produce a 32 percent reduction in delay in the AM peak period and a 14 percent reduction in delay in the PM peak period. Although the combination of these two projects produce a significant reduction in overall delay on the corridor, Phase I of Project F ends at I-5. This results in increased congestion in the bottlenecks on the northerly part of the corridor.

Scenario 8 (General Purpose Lane and Auxiliary Lane Additions)

Scenario 8 adds a general purpose lane and auxiliary lanes in each direction of SR-55 between I-5 and SR-91. This is Phase II of Project F. Funding is anticipated to come from OCTA's M2 Freeway Program, STIP, Federal, and other funding sources. With the completion of the Scenario 8 project, the corridor will experience a three percent reduction in delay in the AM peak period and 40 percent delay reduction in the PM peak period. Total corridor delay will be reduced by over 6,000 hours.

Post Scenarios 1-8 Conditions

After the completion of Scenarios 1 through 8, the 2023 model reveals there is a residual congestion of over 14,000 daily hours of delay. The remaining congestion can be addressed through additional improvements in the future. However, the OCTAM model forecasts do not reflect the economic conditions of the past few years and may overestimate the demand actually experienced in 2023. Even without any improvements to the corridor, congestion is expected to be double due to the high future demand in 2023 according to the OCTAM model. The modeled conditions after implementing projects in Scenarios 1 through 8 represent an overall reduction in delay of over 50 percent from the 29,000 daily hours of delay expected in 2023 if no improvements are made.

Benefit-Cost Analysis

Following an in-depth review of model results, the study team performed a benefit-cost analysis (BCA) for each scenario. The benefit-cost results represent the incremental benefits over the incremental costs of a given scenario.

The study team used the California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) developed by Caltrans to estimate benefits in three key areas: travel time savings, vehicle operating cost savings, and emission reduction savings. The results are conservative since this analysis does not capture the benefits after the 20-year lifecycle or other benefits, such as the reduction in congestion outside the peak periods, safety benefits, and improvements in transit travel times.

Project costs were obtained from various sources, including the State Highway Operation & Protection Program (SHOPP), RTIP, OCTA's Long Range Plan (LRP), Caltrans project planning, and City of Orange. Costs for the advanced ramp and connector metering include widening to accommodate the connector meters within the State's right-of-way, but not the acquisition of new right-of-way. A B/C greater than 1.0 means that a scenario's projects return greater benefits than they cost to construct or implement. It is important to consider the total benefits that a project brings. For example, a large capital expansion project such as adding new general purpose lanes in each direction from I-405 to I-5 has a high capital construction cost, which reduces the B/C ratio, but brings much higher absolute benefits to SR-55 users. Exhibit 6-17 illustrates typical benefit-cost ratios that can be expected for different project types.

The benefit-cost analysis for the SR-55 Corridor is summarized in Exhibit 6-18.

Exhibit 6-17: Benefit-Cost Ratios for Typical Projects

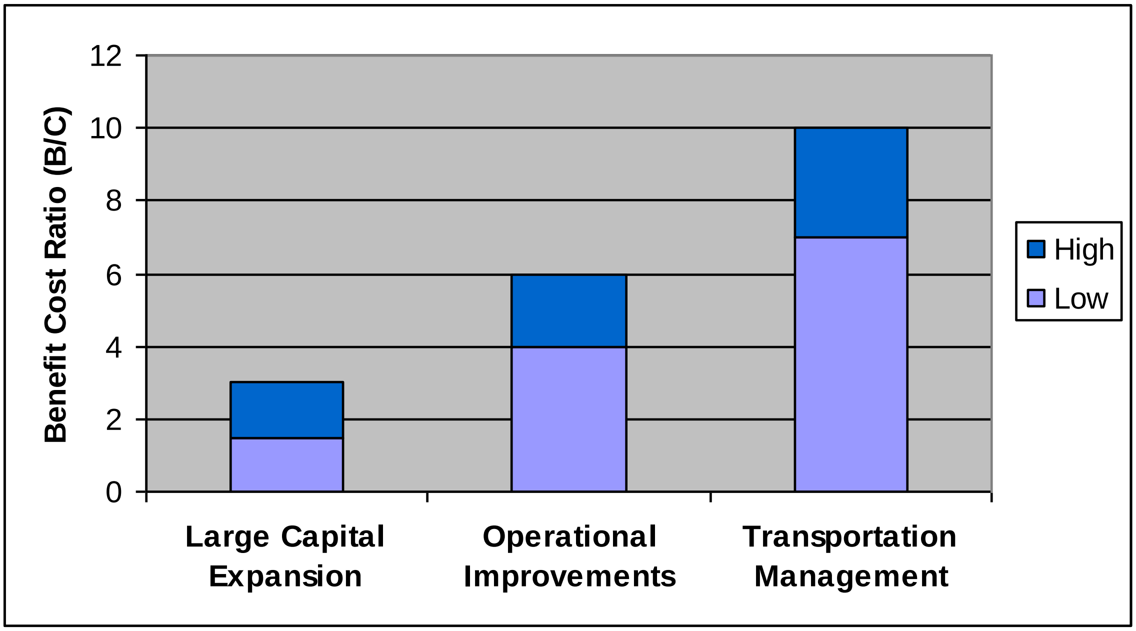
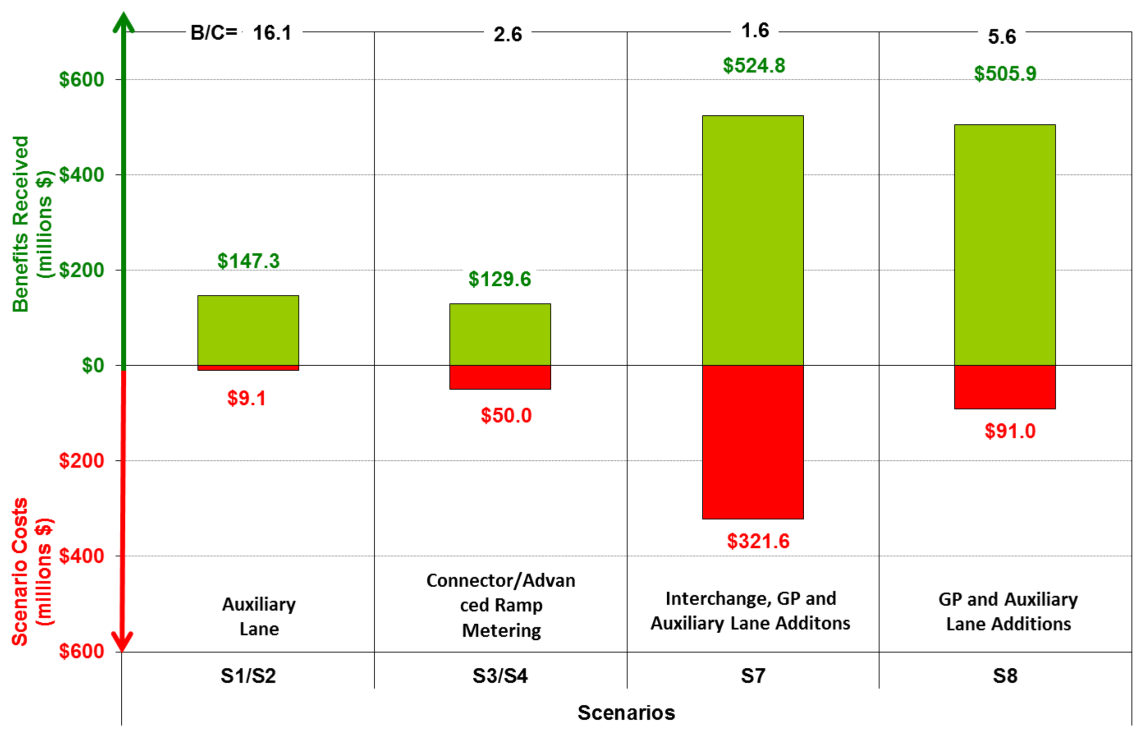


Exhibit 6-18: Scenario Benefit/Cost (B/C) Results



The benefit-cost findings for each scenario are as follows:

- Scenario 1 and Scenario 2 (southbound auxiliary lane between the East Edinger Avenue off-ramp to the Dyer Road off-ramp) produces a very high benefit-cost ratio of about 16.1 with a low cost of a little over $9 million to complete the project.
- Scenarios 3 and 4 (advanced ramp/connector metering) produce a benefit-cost ratio of 4.7. Combined with Scenarios 1 and 2, these scenarios produce an aggregate benefit-cost ratio of 2.6.
- Scenario 7 (interchange, general purpose and auxiliary lane additions from I-405 to I-5) produces an average benefit-cost ratio of 1.6. This project scenario has a high cost of over $320 million. According to the Draft Project Report scheduled to be released for public circulation in April 2014, total cost for the GP and auxiliary lane additions project totals almost $252 million.
- Scenario 8 (general purpose and auxiliary lane additions from I-5 to SR-91) produces a very high benefit cost of 5.6. The total estimated cost of the Scenario 8 project is $91 million. This second phase of the project to widen SR-55 involves much lower construction, support, and right of way costs according to the latest Project Study Report-Project Development Support (PSR-PDS).
- The combined benefit-cost ratio of Scenarios 1, 2, 3, 4, 7, and 8 is 2.8, which is a compelling investment result despite the remaining congestion on the corridor. If all the projects are delivered at current cost estimates, the public will get almost three dollars of benefits for each dollar expended. In current dollars, costs add to over $470 million whereas the benefits are estimated to be over $1.3 billion.
- The projects also alleviate CO_2 greenhouse gas emissions by almost 700,000 tons over 20 years, avoiding more than 30,000 tons per year. These emission impacts are estimated in Cal-B/C using data from the California Air Resources Board (CARB) EMFAC model.

Detailed benefit-cost results can be found in Appendix C.

7. CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the conclusions and recommendations of the SR-55 CSMP based on the analysis presented in this report. Note that many of these conclusions are based primarily on the micro-simulation model results, which were based on the best data available at the time. The study team believes that both the calibration and the scenario results are reasonable given the demand forecasts in the OCTAM model. However, caution should always be used when making decisions based on modeling alone, especially complex micro-simulation models. Project decisions are based on a combination of regional and inter-regional plans and needs. Regional and local acceptance for a project, availability of funding, as well as planning and engineering requirements are all critical for the successful implementation of a project.

Based on the results of the analyses presented herein, the study team offers the following conclusions and recommendations:

- Advanced ramp and connector metering only improves operations during the PM peak period and primarily in the southbound direction. Therefore, the study team recommends that Caltrans implement this strategy during the PM peak period only and not during the AM peak period. Consider implementing advanced metering in the southbound direction first since most of the delay reductions occur in that direction.

- The Scenario 7 projects generate an average benefit-cost ratio of 1.6 due to the high cost of the capacity enhancing project that extends from I-405 to I-5. Since this is Phase I of the overall project to widen the SR-55 corridor, there are still high levels of congestion that exist, particularly on the northerly end of the project area. Expansion on the northerly part of the corridor is required to improve mobility.

- With Phase II (Scenario 8) of the capacity enhancing project to continue from I-5 to SR-91, mobility improvements and much of the congestion that remains in Scenario 7 is reduced. This phase of the project also costs much less to design and construct than Phase I, resulting in a much higher benefit-cost ratio.

- After these improvements are completed, congestion actually improves slightly from what it is today (to 14,000 daily hours of delay compared to 15,000 daily hours of delay today). To address the remaining congestion, Caltrans should consider additional operational and capacity enhancing projects to reduce congestion further.

- Enhanced incident management also shows promise. With an average delay savings of over 300 vehicle-hours per incident, the corridor would experience some delay savings as well.

Speed contour maps illustrate how the modeled scenarios can change performance on the corridor. Exhibits 7-1 and 7-2 show speed contour maps for the 2023 "do minimum" horizon year with the growth in congestion before any improvements. Exhibits 7-3 and 7-4 show the conditions at the conclusion of Scenario 7, the final scenario tested. A comparison of these charts shows that the tested scenarios reduce the extent and duration of congestion. While the scenarios reduce congestion by over 50 percent compared to no improvements, some congestion still remains.

Exhibits 7-3 and 7-4 show the remaining residual congestion and bottleneck locations in the southbound AM and northbound PM directions, respectively. In the southbound direction, much of the congestion has been eliminated, but smaller bottlenecks at I-5 and SR-22 remain. In the northbound direction, much of the congestion that queued back from I-5 to the end of the corridor has been reduced with remaining congestion from I-5 to Dyer Road. These bottlenecks should be the target of future improvements on the corridor.

Exhibit 7-1: 2023 SB AM Peak Model Speed Contours Before Improvements

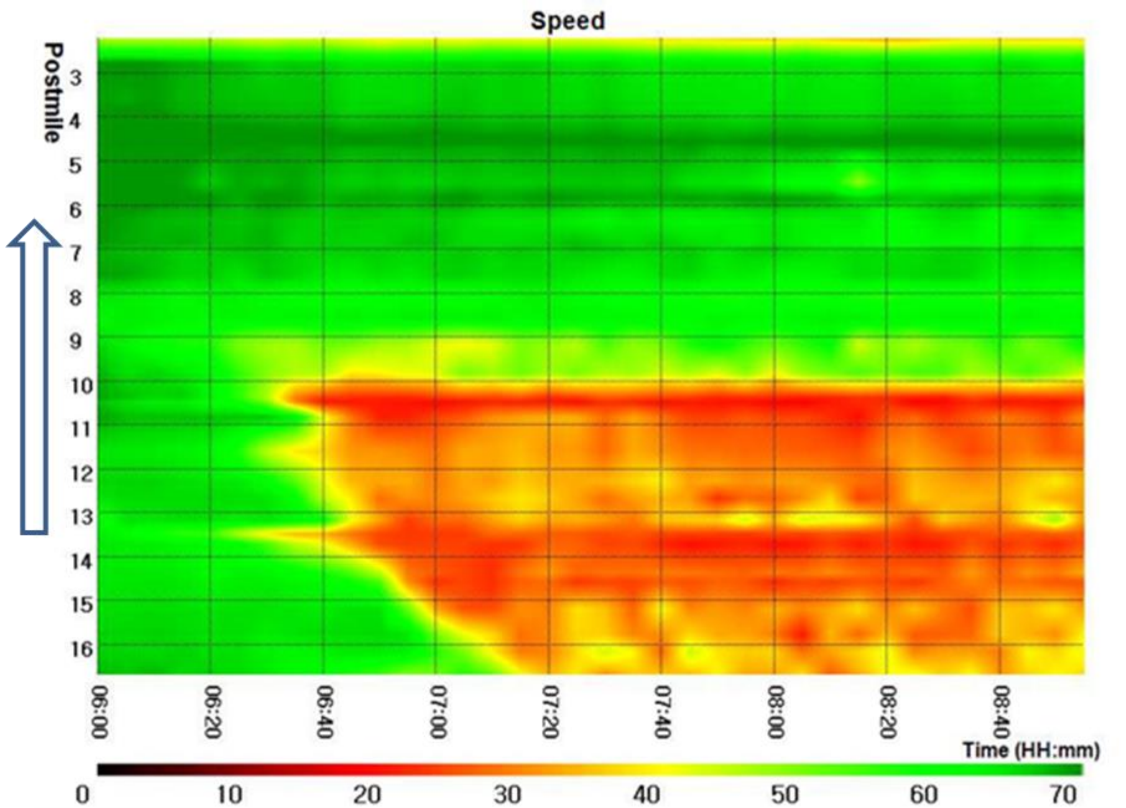


Exhibit 7-2: 2023 NB PM Peak Model Speed Contours Before Improvements

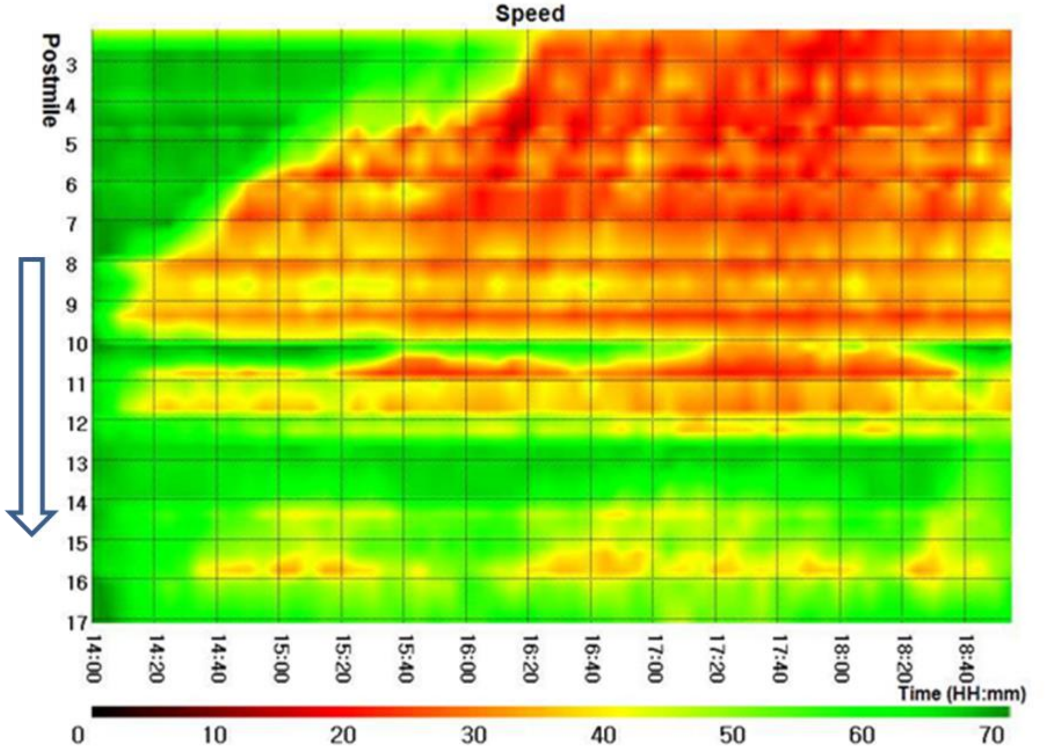


Exhibit 7-3: 2023 SB AM Peak Model Speed Contours After Improvements

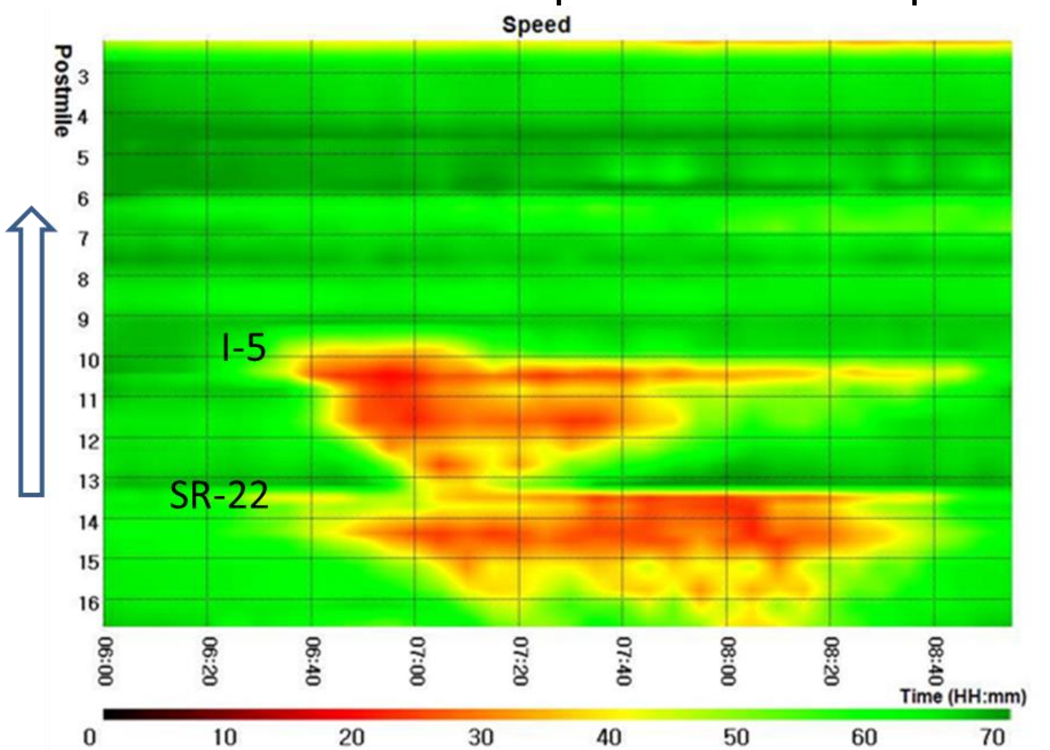
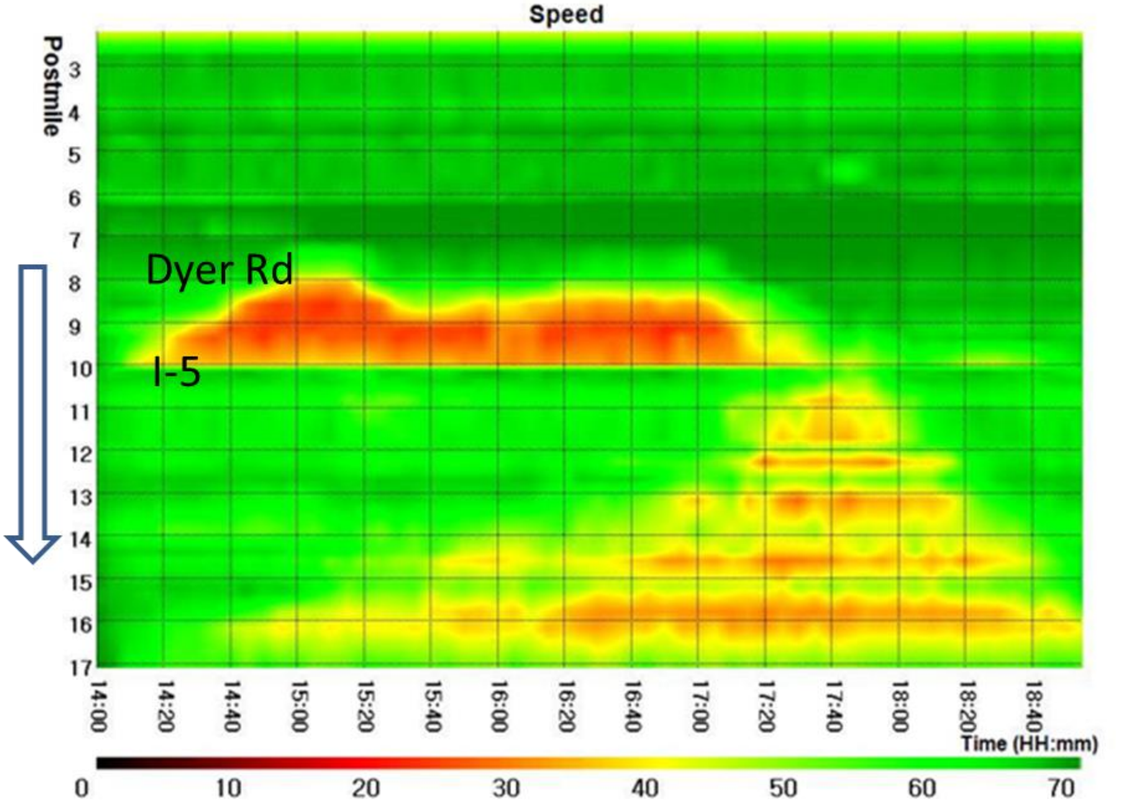


Exhibit 7-4: 2023 NB PM Peak Model Speed Contours After Improvements



This is the first generation CSMP for the SR-55 Corridor. It is important to stress that CSMPs should be updated on a regular basis. This is particularly important since traffic conditions and patterns can differ from current projections. After projects are delivered, it is also useful to compare actual results with ones estimated in this document so that models can be further improved.

CSMPs, or a variation thereof, should become a normal course of business that is based on detailed performance assessments, an in-depth understanding of the reasons for performance deterioration, and an analytical framework that allows for evaluating complementary operational strategies that maximize the productivity of the current system. A traffic report with all the speed contours is available under separate cover.

Appendix A: Summer Midday Congestion

The summer midday congestion analysis was conducted for summer 2012. PeMS data analyses conducted between 2008 through 2011 in the CSMP showed midday congestion particularly during the summer seasons. Subsequently, Caltrans requested that System Metrics Group, Inc. (SMG) investigate traffic conditions during the summer of 2012 to confirm the occurrence of midday congestion.

BOTTLENECK CONFIRMATION

Exhibit A-1 shows the weekday bottlenecks that were identified and confirmed by the study team (SMG and Caltrans) as part of the SR-55 Final Comprehensive Performance Assessment Report completed in April 2012. As shown in the exhibit, the 19th Street Intersection bottleneck in the southbound direction is a seasonal bottleneck that is a result of heavy demand during the midday summer months. PeMS data was reviewed for the southbound corridor for 2012 from January to August. Additionally, field investigation was conducted in mid-August to confirm and verify the conditions out in the field.

Exhibit A-1 – SR-55 Bottlenecks

Southbound

No.	Major Bottleneck Location	Hidden Bottleneck Location	Causality	Active Period		From		To (At)		Distance (miles)
				AM	PM	Abs	CA	Abs	CA	
S1A		Katella On	Merging	✓				15.0	15.0	
S1	SR22 Off		Lane drop south of SR22 Off (mainline from 4 lanes to 3)	✓	☑	17.9	17.9	13.0	13.0	4.9
S2	17 Street On		Merging and weaving with 4th Street Off	✓	☑	13.0	13.0	11.5	11.5	1.5
S3	I-5 On		Merging (consecutive connectors on)	✓	☑	11.5	11.5	10.0	10.0	1.5
S4	Edinger On		Merging	✓	✓	10.0	10.0	9.0	R9.0	1.0
S5	Baker Off		Lane drop south of Baker Off (mainline from 4 lanes to 3)		✓	9.0	R9.0	5.5	R5.5	3.5
S6A		19th St I/S	Seasonal bottleneck from heavy demand during midday summer months					2.0	R2.0	
	None					5.5	R5.5	2.2	R2.2	3.3
										15.7

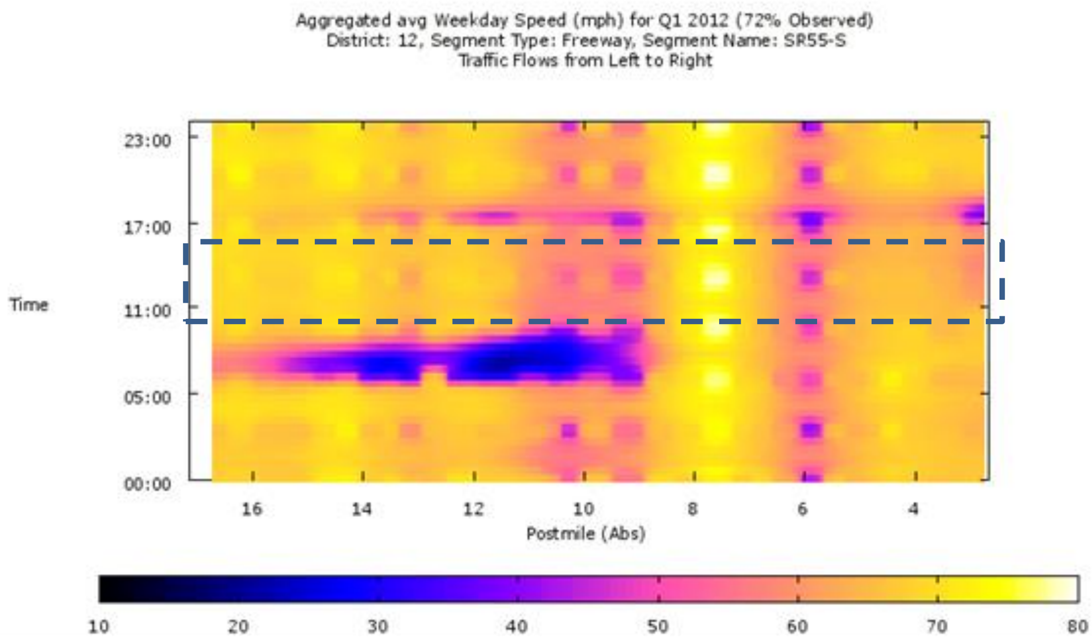
NOTES:
Causality was verified with multiple field observations and video taping during November and December 2011.
Hidden bottlenecks are bottlenecks hidden by queuing from downstream bottleneck or demand held by upstream bottleneck(s).
Bottleneck area is the segment from one major bottleneck location to the next major bottleneck location. It does not represent the queue length.
✓ Primarily active during this peak period
☑ Less congested bottleneck but also occurs during this peak period

Exhibit A-2 shows the southbound weekday speed contours for the first two quarters of 2012. This exhibit shows that during the first quarter of 2012, there is no midday congestion anywhere on the corridor. During the second quarter, average speeds slow down slightly to an average of 45 mph. Note that during the first five months of 2012, southbound SR-55 does not experience any midday congestion.

Exhibit A-3 shows that summer beach traffic in the months of June through August cause midday congestion starting around 11:00 a.m. and lasting until approximately 2:30 p.m. in the afternoon. SR-55 is the only freeway that provides direct access to many of Orange County's beach cities that are popular with tourists as well as with local residents.

This increase in demand occurs most likely from schools being out of session and people taking summer vacations. As shown in Exhibit A-4, speeds drop below 35 mph during the midday hours at the very southern end of the corridor where the freeway ends at 19th Street. This arterial intersection causes a bottleneck that ends just upstream of Fair Drive in Costa Mesa.

Exhibit A-2 – Southbound SR-55 Q1 & Q2 2012 Speed Contours



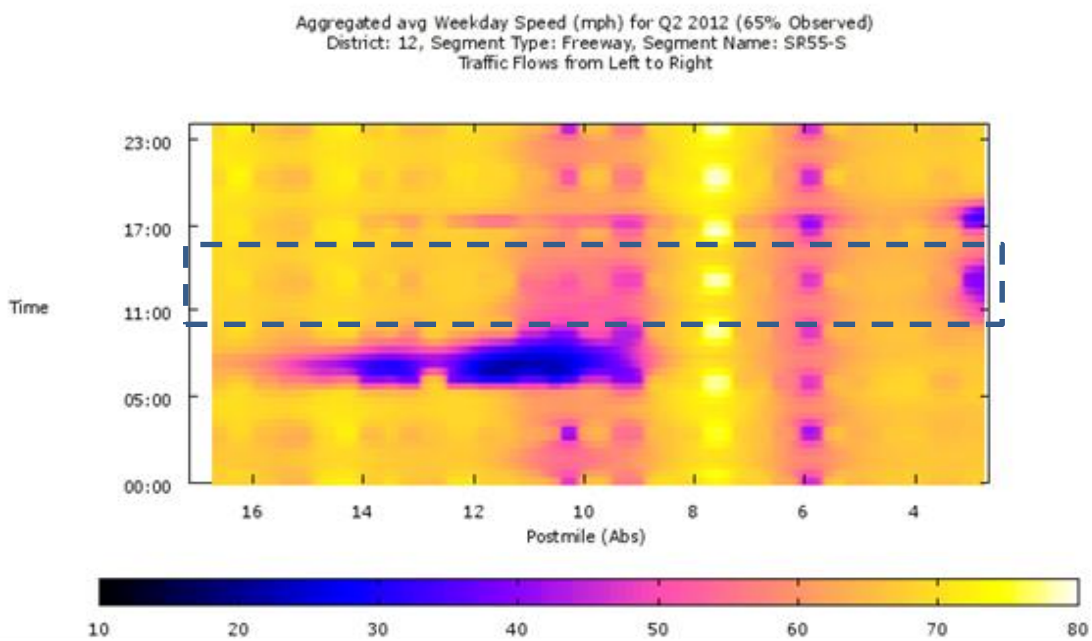
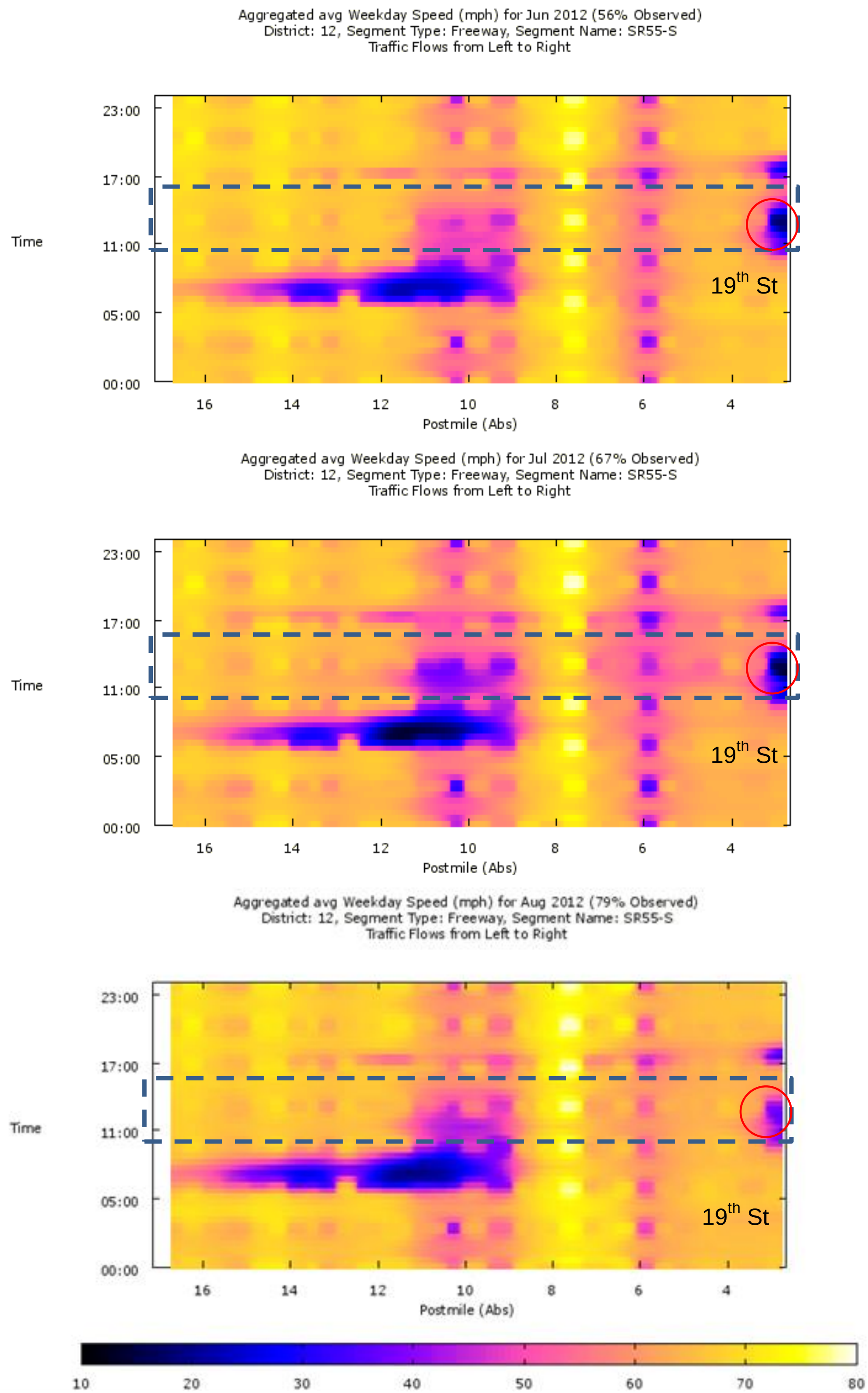
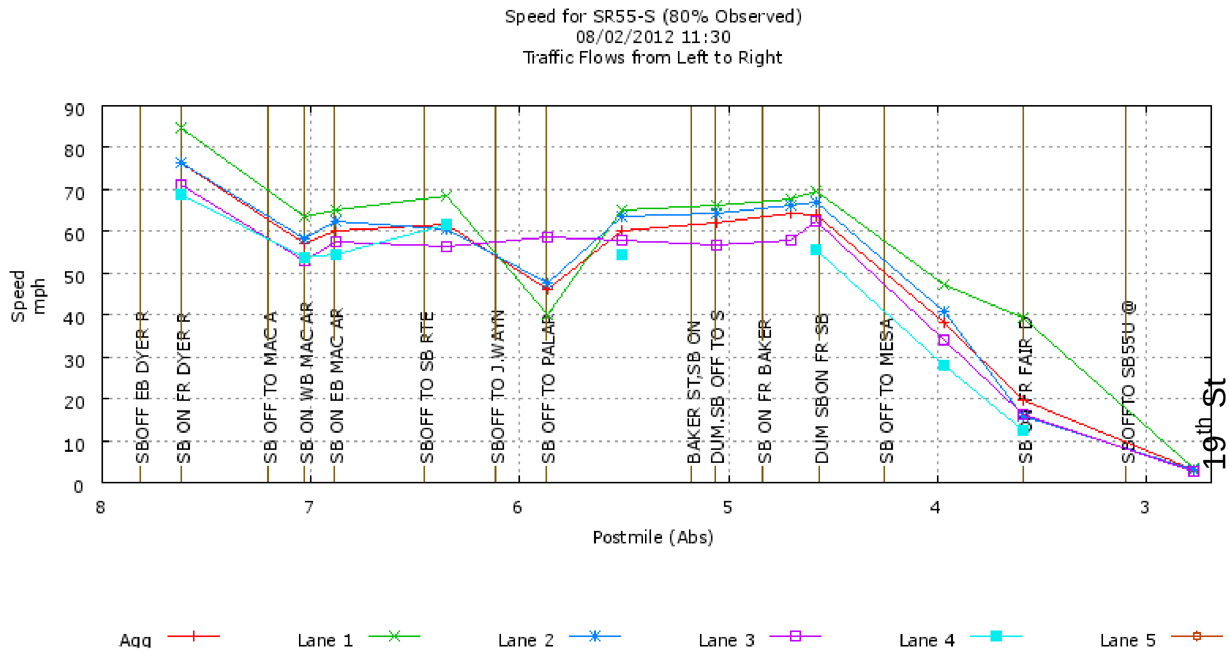


Exhibit A-3 – Southbound SR-55 June-August 2012 Speed Contours



A closer look at the southern end of the corridor shows that on a typical Thursday on August 2, 2012 (Exhibit A-4) at 11:30 a.m., the 19th Street Intersection bottleneck speeds slow down to a stop and queues back to Mesa Drive, just south of the SR-73 interchange.

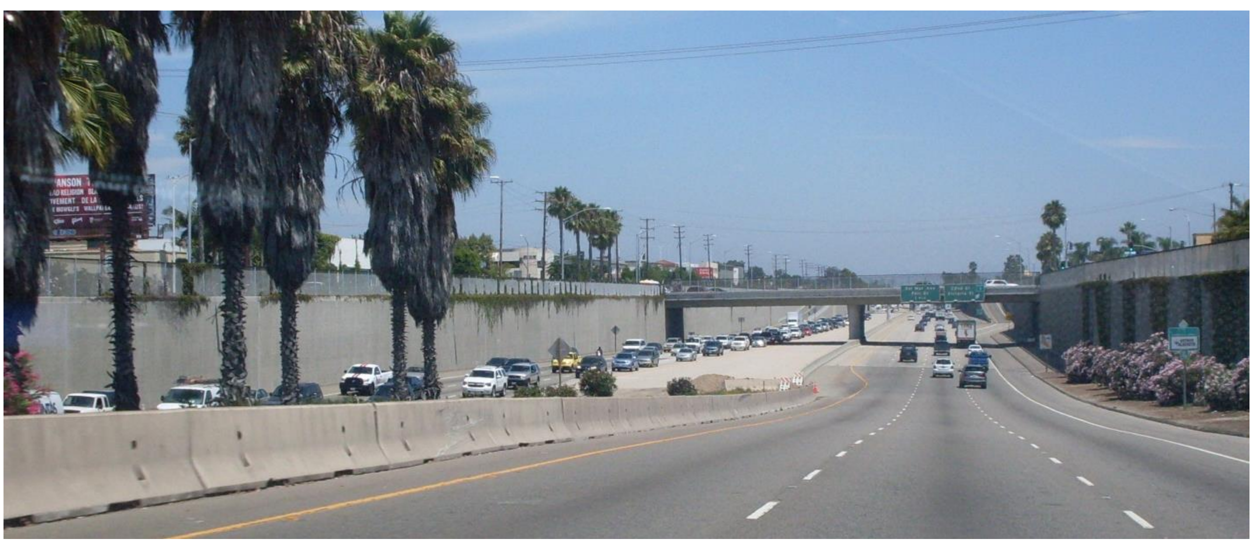
Exhibit A-4 – Southbound SR-55 Speed Profile



Field investigation conducted on Wednesday, August 15, 2012 during the midday also confirmed the existence of this bottleneck. Exhibit A-5 shows the queuing experienced in the middle of the bottleneck south of Fair Drive. Traffic slows where all three lanes are stop and go. At 11:30 a.m., it took over 10 minutes to travel 0.75 miles from the freeway to reach the signalized intersection at 19th Street. Exhibit A-6 shows the southbound congestion viewed from the northbound direction, where traffic is at free flow speeds. This exhibit captures the queuing that occurs well downstream of the intersection.

Exhibit A-5 – Southbound SR-55 Congestion

Exhibit A-6 – Southbound SR-55 Congestion Looking North

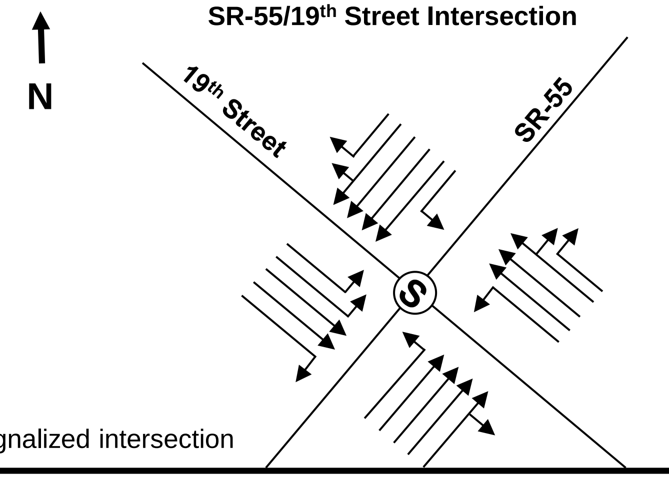


BOTTLENECK CAUSALITY

The SR-55 Costa Mesa Freeway terminates at the 19th Street intersection. This intersection is signalized and surrounded by commercial developments in all directions. Exhibit A-7 shows the SR-55/19th Street lane configurations. This intersection was recently reconfigured and widened in 2011. This bottleneck is caused by the traffic signal at the SR-55 freeway terminus at 19th Street. Although the southbound direction has the longest allocated green time for the intersection (90 second green cycle), vehicles exiting the freeway cannot clear the intersection therefore resulting in queuing of traffic back onto the freeway. The rightmost lane south of the intersection becomes a right turn only lane which requires through movement vehicles to merge into the third lane. This weaving, combined with the traffic signal creates a bottleneck condition at the intersection.

Exhibit A-7 – SR-55/19th Street Lane Configuration

SR-55/19th Street Intersection



S = signalized intersection

Appendix B: Detailed Scenario Descriptions

This appendix describes the scenarios and the projects from the Transportation Improvement Program (RTIP), the Regional Transportation Plan (RTP), Measure M2, Caltrans Planning, and other sources that are used to build the scenarios to be tested using the Paramics micro-simulation model.

Exhibit B-1 shows the scenarios for both the 2011 Base Year and 2023 Horizon Year forecast.

Exhibit B-1: Project Lists for Micro-Simulation Scenarios

Scenarios	Proj ID	Improvement	Lead Agency	Expected Completion Date	Est Project Cost, Nominal $ (in $1,000's)
1 (2010-1) 2 (2020-1)	EA 0G960	Construct one auxiliary lane on s/b SR-55 between E. Edinger Ave off-ramp to Dyer Rd on-ramp	Caltrans	2012	$9,126
3 (2010-2) 4 (2020-2)	Proposed (SMG)	Advanced ramp metering with queue control	Caltrans		$10,000
	Proposed (SMG)	Connector metering on I-5 and I-405 interchanges	Caltrans		$40,000
5 (2020-3) 6 (2020-4)	Proposed (SMG)	Enhanced Incident Management System - incident clearance time reduction from current and with improvements (2020 Model Only)	Caltrans		$10,000
7 (2020-5)	EA 07810	Meats Ave @ SR55 interchange. Construct off-ramps. Part of SR-55 Enhancement Projects (0 to 2 lanes)	Orange	2017	$70,000
	EA 0J340	I-405 TO I-5 Phase I: Add new lanes to SR-55 between I-5 and I-405, including merging lanes between interchanges to smooth traffic flow	OCTA	2020	$251,600
8 (2020-6)	EA 0K720	SR-91 to I-5 Phase II: Add new lanes to SR-55 between SR-91 and I-5, including merging lanes between interchanges to smooth traffic flow; evaluate operational improvements	OCTA	2023	$91,000

Appendix C: Benefit-Cost Analysis Results

This appendix provides more detailed Benefit-Cost Analysis (BCA) results than found in Section 6 of the SR-55 Corridor System Management Plan (CSMP) Final Report. The BCA results for this CSMP were estimated by using the *California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) Version 5.0 Corridor*.

Caltrans uses Cal-B/C to conduct investment analyses of projects proposed for the interregional portion of the State Transportation Improvement Program (STIP), the State Highway Operations and Protection Program (SHOPP), and other ad hoc analyses requiring BCA. Cal-B/C is a spreadsheet-based tool that can prepare analyses of highway, transit, and passenger rail projects. Users input data defining the type, scope, and cost of projects. The model calculates life-cycle costs, net present values, benefit-cost ratios, internal rates of return, payback periods, annual benefits, and life-cycle benefits. Cal-B/C can be used to evaluate capacity expansion projects, transportation management systems (TMS), and operational improvements.

Cal-B/C measures, in constant dollars, four categories of benefits:

- Travel time savings (reduced travel time and new trips)
- Vehicle operating cost savings (fuel and non-fuel operating cost reductions)
- Accident cost savings (safety benefits)
- Emission reductions (air quality and greenhouse gas benefits).

Each of these benefits was estimated for the peak period for the following categories:

- **Life-Cycle Costs** - present values of all net project costs, including initial and subsequent costs in real current dollars.
- **Life-Cycle Benefits** - sum of the present value benefits for the project.
- **Net Present Value** - life-cycle benefits minus the life-cycle costs. The value of benefits exceeds the value of costs for a project with a positive net present value.
- **Benefit/Cost Ratio** - benefits relative to the costs of a project. A project with a benefit-cost ratio greater than one has a positive economic value.
- **Rate of Return on Investment** - discount rate at which benefits and costs are equal. For a project with a rate of return greater than the discount rate, the benefits are greater than costs and the project has a positive economic value. The user can use rate of return to compare projects with different costs and different benefit flows over different time periods. This is particularly useful for project staging.
- **Payback Period** - number of years it takes for the net benefits (life-cycle benefits minus life-cycle costs) to equal the initial construction costs. For a project with a

payback period longer than the life-cycle of the project, initial construction costs are not recovered. The payback period varies inversely with the benefit-cost ratio. A shorter payback period yields a higher benefit-cost ratio.

The model calculates these results over a standard 20-year project life-cycle, itemizes each user benefit, and displays the annualized and life-cycle user benefits. Below the itemized project benefits, Cal-B/C displays three additional benefit measures:

- **Person-Hours of Time Saved** - reduction in person-hours of travel time due to the project. A positive value indicates a net benefit.
- **CO_2 Emissions Saved (tons)** - CO_2 emissions saved because of the project. The emissions are estimated using average speed categories using data from the California Air Resources Board (CARB) EMFAC model. This is a gross calculation because the emissions factors do not take into account changes in speed cycling or driver behavior. A negative value indicates a project benefit. Projects in areas with severe congestion will generally lower CO_2 emissions.
- **CO_2 Emissions Saved (in millions of dollars)** - valued CO_2 emissions using a recent economic valuing methodology.

A copy of Cal-B/C v5.0 Corridor, the User's Guide, and detailed technical documentation can be found at the Caltrans' Division of Transportation Planning, Office of Transportation Economics website at www.dot.ca.gov/hq/tpp/offices/ote/benefit.html.

The exhibits in this appendix are listed as follows:

- Exhibit C-1: BCA Results – S1/S2 – Auxiliary Lane
- Exhibit C-2: BCA Results – S3/S4 – S1/S2 + Advanced Ramp/Connector Metering
- Exhibit C-3: BCA Results – S7 – Interchange and General Purpose/Auxiliary Lane Additions
- Exhibit C-4: BCA Results – S8 – General Purpose/Auxiliary Lane Additions
- Exhibit C-5: BCA Results – S9 – HOV Lane Additions
- Exhibit C-6: Cumulative BCA Results

Exhibit C-1: BCA Results - S1/S2 – Auxiliary Lane

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$9.1
Life-Cycle Benefits (mil. $)	$147.3
Net Present Value (mil. $)	$138.2
Benefit / Cost Ratio:	16.1
Rate of Return on Investment:	70.5%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$6.7	$133.4
Veh. Op. Cost Savings	$0.6	$12.1
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.1	$1.8
TOTAL BENEFITS	$7.4	$147.3
Person-Hours of Time Saved	836,130	16,722,607
CO_2 Emissions Saved (tons)	3,066	61,329
CO_2 Emissions Saved (mil. $)	$0.1	$1.1

Incremental Costs (mil. $)	$9.1
Incremental Benefits (mil. $)	$147.3
Incremental Benefit / Cost Ratio	16.1

Exhibit C-2: BCA Results – S3/S4 – S1/S2 + Advanced Ramp/Connector Metering

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$59.2
Life-Cycle Benefits (mil. $)	$276.9
Net Present Value (mil. $)	$217.7
Benefit / Cost Ratio:	4.7
Rate of Return on Investment:	24.2%
Payback Period:	5 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$12.6	$251.5
Veh. Op. Cost Savings	$1.1	$22.1
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.2	$3.3
TOTAL BENEFITS	$13.8	$276.9
Person-Hours of Time Saved	1,584,738	31,694,767
CO_2 Emissions Saved (tons)	5,959	119,176
CO_2 Emissions Saved (mil. $)	$0.1	$2.1

Incremental Costs (mil. $)	$50.0
Incremental Benefits (mil. $)	$129.6
Incremental Benefit / Cost Ratio	2.6

Exhibit C-3: BCA Results – S7 – Interchange and General Purpose/Auxiliary Lane Additions

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$321.6
Life-Cycle Benefits (mil. $)	$524.8
Net Present Value (mil. $)	$203.2
Benefit / Cost Ratio:	1.6
Rate of Return on Investment:	10.3%
Payback Period:	9 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$23.2	$463.1
Veh. Op. Cost Savings	$2.7	$53.6
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.4	$8.1
TOTAL BENEFITS	$26.2	$524.8
Person-Hours of Time Saved	2,695,012	53,900,238
CO_2 Emissions Saved (tons)	12,854	257,076
CO_2 Emissions Saved (mil. $)	$0.2	$4.9

Exhibit C-4: BCA Results – S8 – General Purpose/Auxiliary Lane Additions

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$91.0
Life-Cycle Benefits (mil. $)	$505.9
Net Present Value (mil. $)	$414.9
Benefit / Cost Ratio:	5.6
Rate of Return on Investment:	40.9%
Payback Period:	3 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$21.7	$434.2
Veh. Op. Cost Savings	$3.1	$62.2
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.5	$9.4
TOTAL BENEFITS	$25.3	$505.9
Person-Hours of Time Saved	2,525,241	50,504,813
CO_2 Emissions Saved (tons)	15,061	301,217
CO_2 Emissions Saved (mil. $)	$0.3	$5.7

Exhibit C-6: Cumulative BCA Results

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$471.8
Life-Cycle Benefits (mil. $)	$1,307.5
Net Present Value (mil. $)	$835.8
Benefit / Cost Ratio:	2.8
Rate of Return on Investment:	n/a
Payback Period:	n/a

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$57.4	$1,148.8
Veh. Op. Cost Savings	$6.9	$137.9
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$1.0	$20.8
TOTAL BENEFITS	$65.4	$1,307.5
Person-Hours of Time Saved	6,804,991	136,099,819
CO_2 Emissions Saved (tons)	33,873	677,469
CO_2 Emissions Saved (mil. $)	$ 0.63	$ 12.67